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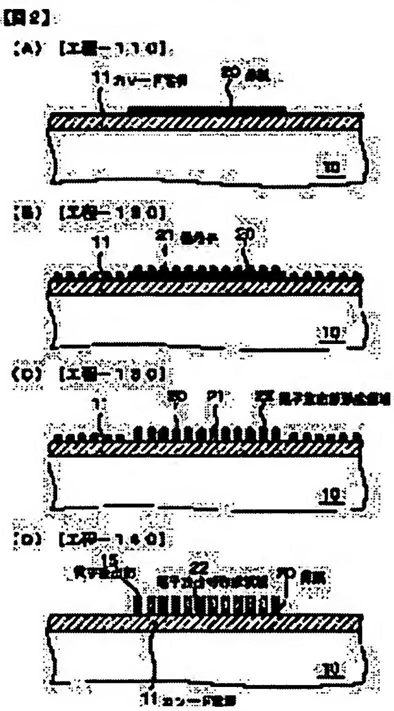
(54) ELECTRON EMITTING DEVICE AND MANUFACTURING METHOD FOR IT, COLD CATHODE FIELD ELECTRON EMITTING ELEMENT AND MANUFACTURING METHOD FOR IT, COLD CATHODE FIELD ELECTRON EMITTING DISPLAY DEVICE AND MANUFACTURING METHOD FOR IT, AND METHOD FOR ETCHING THIN FILM



(57)Abstract:
PROBLEM TO BE SOLVED: To provide a method for manufacturing a cold cathode field electron emitting element, capable of sharpening a part to emit an electron in an electron emitting part composed by a carbon based material.
SOLUTION: This method for manufacturing the cold cathode field electron emitting element is provided with a process to form a thin film 20 of a metal or a metal compound on a cathode electrode 11 formed on a supporting body 10, a process to form an island-shaped electron emitting part forming region 22 comprising the thin film 20 left by applying anisotropic etching to the thin film 20 with a corpuscle 21 as an etching mask after disposing the corpuscle 21 on the thin film 20, and a process to selectively form an electron emitting part 15 of crystalline graphite on the electron emitting part forming region 22 based on a CVD method.

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CLAIMS

[Claim(s)]
[Claim 1] (A) The process which forms the thin film which consists of a metal or metallic compounds on a conductor layer, (B) Anisotropic etching is performed to a thin film by using as the mask for etching the process which arranges a particle on a thin film, and (C) this particle, and it leaves alternatively the thin film located under a particle. Subsequently The process which forms the electron emission section formation field of the shape of an island which consists of the thin film which removed the particle, with was left behind, (D) The manufacture approach of the electron emission equipment characterized by providing the process which forms alternatively the electron emission section which consists of the graphite which has crystallinity on an electron emission section formation field based on chemical vapor deposition.
[Claim 2] It is the manufacture approach of the electron emission equipment according to claim 1 characterized by for the average diameters of a particle being 1x10 to 9 m thru/or 1x10 to 7 m, and satisfying ER2 <=0.1ER1 when the average thickness of a thin film is 1x10 to 8 m thru/or 5x10 to 7 m and the etch rate of a particle [in / for the etch rate of the thin film in the direction of a normal of a thin film / ER1 and the direction of a normal of a thin film] is set to ER2.
[Claim 3] The manufacture approach of the electron emission equipment according to claim 1 characterized by carrying out by the approach of removing a solvent after applying the solvent which distributed the particle for arrangement of the particle to a thin film top on a thin film.
[Claim 4] The manufacture approach of the electron emission equipment according to claim 1 characterized by forming a thin film with chemical vapor deposition, physical vapor growth, or plating.
[Claim 5] A particle is the manufacture approach of the electron emission equipment according to claim 1 characterized by consisting of a silica or an alumina.

[Claim 6] (a) Electron emission equipment characterized by having the electron emission section which consists of the graphite which has the crystallinity formed on the electron emission section formation field of the shape of an island which consists of the metal or metallic compounds formed on the conductor layer, and (b) this electron emission section formation field.
[Claim 7] It is electron emission equipment according to claim 6 which the average diameters of an electron emission section formation field are 1x10 to 9 m thru/or 1x10 to 7 m, and is characterized by the average thickness of an electron emission section formation field being 1x10 to 8 m thru/or 5x10 to 7 m.
[Claim 8] The radius of curvature of the point of the electron emission section is electron emission equipment according to claim 7 characterized by being 1x10 to 9 m thru/or 1x10 to 7 m.
[Claim 9] (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, And the process which is the manufacture approach of a cold cathode field-electron-emission component of providing the electron emission section formed on (c) electron emission section formation field, and forms a cathode electrode on the (A) base material, (B) The process which forms the thin film which consists of a metal or metallic compounds on a cathode electrode, (C) Anisotropic etching is performed to a thin film by using as the mask for etching the process which arranges a particle on a thin film, and (D) this particle, and it leaves alternatively the thin film located under a particle. Subsequently The process which forms the electron emission section formation field of the shape of an island which consists of the thin film which removed the particle, with was left behind, (E) The manufacture approach of the cold cathode field-electron-emission component characterized by providing the process which forms alternatively the electron emission section which consists of the graphite which has crystallinity on an electron emission section formation field based on chemical vapor deposition.
[Claim 10] (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, (c) It is arranged above the electron emission section formed on the electron emission section formation field, and (d) electron emission section. The process which is the manufacture approach of a cold cathode field-electron-emission component of providing the gate electrode which has opening, and forms a cathode electrode on the (A) base material, (B) The process which forms the thin film which consists of a metal or metallic compounds on a cathode electrode, (C) Anisotropic etching is performed to a thin film by using as the mask for etching the process which arranges a particle on a thin film, and (D) this particle, and it leaves alternatively the thin film located under a particle. Subsequently The process which forms the electron emission section formation field of the shape of an island which consists of the thin film which removed the particle, with was left behind, (E) The manufacture approach of the cold cathode field-electron-emission component characterized by providing the process which forms alternatively the electron emission section which consists of the graphite which has crystallinity on an electron emission section formation field based on chemical vapor deposition.
[Claim 11] The manufacture approach of the cold cathode field-electron-emission component according to claim 10 characterized by forming an insulating layer in the whole surface after said process (E), forming the gate electrode which has opening

subsequently, forming the 2nd opening in an insulating layer further, and providing further the process which exposes the electron emission section at the pars basilaris ossis occipitalis of the 2nd opening.
[Claim 12] The manufacture approach of the cold cathode field-electron-emission component according to claim 10 characterized by forming an insulating layer in the whole surface after said process (B), forming the gate electrode which has opening subsequently, forming the 2nd opening in an insulating layer further, and providing further the process which exposes a thin film at the pars basilaris ossis occipitalis of the 2nd opening.
[Claim 13] The manufacture approach of the cold cathode field-electron-emission component according to claim 10 characterized by forming an insulating layer in the whole surface after said process (D), forming the gate electrode which has opening subsequently, forming the 2nd opening in an insulating layer further, and providing further the process which exposes a cathode electrode and an electron emission section formation field at the pars basilaris ossis occipitalis of the 2nd opening.
[Claim 14] The manufacture approach of the cold cathode field-electron-emission component according to claim 10 characterized by forming an insulating layer in the whole surface after said process (A), forming the gate electrode which has opening subsequently, forming the 2nd opening in an insulating layer further, and providing further the process which exposes a cathode electrode at the pars basilaris ossis occipitalis of the 2nd opening.
[Claim 15] The average diameters of a particle are 1x10 to 9 m thru/or 1x10 to 7 m, and the average thickness of a thin film is 1x10 to 8 m thru/or 5x10 to 7 m. The manufacture approach of a cold cathode field-electron-emission component given in any 1 term of claim 9 characterized by satisfying ER2 <=0.1ER1 when the etch rate of a particle [in / for the etch rate of the thin film in the direction of a normal of a thin film / ER1 and the direction of a normal of a thin film] is set to ER2 thru/or claim 14.
[Claim 16] The manufacture approach of a cold cathode field-electron-emission component given in any 1 term of claim 9 characterized by carrying out by the approach of removing a solvent after applying the solvent which distributed the particle for arrangement of the particle to a thin film top on a thin film thru/or claim 14.
[Claim 17] The manufacture approach of a cold cathode field-electron-emission component given in any 1 term of claim 9 characterized by forming a thin film with chemical vapor deposition, physical vapor growth, or plating thru/or claim 14.
[Claim 18] A particle is the manufacture approach of a cold cathode field-electron-emission component given in any 1 term of claim 9 characterized by consisting of a silica or an alumina thru/or claim 14.
[Claim 19] The cathode panel by which two or more cold cathode field-electron-emission components were prepared, and the anode panel equipped with the fluorescent substance layer and the anode electrode It is joined in those periphery sections and changes. A cold cathode field-electron-emission component (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, And the process which is the manufacture approach of a cold cathode field-electron-emission display of providing the electron emission section formed on (c) electron emission section formation field, and forms a cathode electrode on the (A) base material, (B) The process which forms the thin film which

consists of a metal or metallic compounds on a cathode electrode, (C) Anisotropic etching is performed to a thin film by using as the mask for etching the process which arranges a particle on a thin film, and (D) this particle, and it leaves alternatively the thin film located under a particle. Subsequently The process which forms the electron emission section formation field of the shape of an island which consists of the thin film which removed the particle, with was left behind, (E) The manufacture approach of the cold cathode field-electron-emission display characterized by providing the process which forms alternatively the electron emission section which consists of the graphite which has crystallinity on an electron emission section formation field based on chemical vapor deposition.

[Claim 20] The cathode panel by which two or more cold cathode field-electron-emission components were prepared, and the anode panel equipped with the fluorescent substance layer and the anode electrode It is joined in those periphery sections and changes. A cold cathode field-electron-emission component (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, (c) It is arranged above the electron emission section formed on the electron emission section formation field, and (d) electron emission section. The process which is the manufacture approach of a cold cathode field-electron-emission display of providing the gate electrode which has opening, and forms a cathode electrode on the (A) base material, (B) The process which forms the thin film which consists of a metal or metallic compounds on a cathode electrode, (C) Anisotropic etching is performed to a thin film by using as the mask for etching the process which arranges a particle on a thin film, and (D) this particle, and it leaves alternatively the thin film located under a particle. Subsequently The process which forms the electron emission section formation field of the shape of an island which consists of the thin film which removed the particle, with was left behind, (E) The manufacture approach of the cold cathode field-electron-emission display characterized by providing the process which forms alternatively the electron emission section which consists of the graphite which has crystallinity on an electron emission section formation field based on chemical vapor deposition.

[Claim 21] The manufacture approach of the cold cathode field-electron-emission display according to claim 20 characterized by forming an insulating layer in the whole surface after said process (E), forming the gate electrode which has opening subsequently, forming the 2nd opening in an insulating layer further, and providing further the process which exposes the electron emission section at the pars basilaris ossis occipitalis of the 2nd opening.

[Claim 22] The manufacture approach of the cold cathode field-electron-emission display according to claim 20 characterized by forming an insulating layer in the whole surface after said process (B), forming the gate electrode which has opening subsequently, forming the 2nd opening in an insulating layer further, and providing further the process which exposes a thin film at the pars basilaris ossis occipitalis of the 2nd opening.

[Claim 23] The manufacture approach of the cold cathode field-electron-emission display according to claim 20 characterized by forming an insulating layer in the whole surface after said process (D), forming the gate electrode which has opening subsequently, forming the 2nd opening in an insulating layer further, and providing further the process which exposes a cathode electrode and an electron emission section formation field at the

pars basilaris ossis occipitalis of the 2nd opening.
[Claim 24] The manufacture approach of the cold cathode field-electron-emission display according to claim 20 characterized by forming an insulating layer in the whole surface after said process (A), forming the gate electrode which has opening subsequently, forming the 2nd opening in an insulating layer further, and providing further the process which exposes a cathode electrode at the pars basilaris ossis occipitalis of the 2nd opening.
[Claim 25] (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, It is a cold cathode field-electron-emission component possessing the electron emission section formed on (c) electron emission section formation field. And this electron emission section formation field It is the cold cathode field-electron-emission component characterized by consisting of a metal or metallic compounds and this electron emission section consisting of the graphite which has the crystallinity formed on this electron emission section formation field.
[Claim 26] (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, (c) It is arranged above the electron emission section formed on the electron emission section formation field, and (d) electron emission section. It is a cold cathode field-electron-emission component possessing the gate electrode which has opening. This electron emission section formation field It is the cold cathode field-electron-emission component characterized by consisting of a metal or metallic compounds and this electron emission section consisting of the graphite which has the crystallinity formed on this electron emission section formation field.
[Claim 27] It is the cold cathode field-electron-emission component according to claim 25 or 26 which the average diameters of an electron emission section formation field are 1x10 to 9 m thru/or 1x10 to 7 m, and is characterized by the average thickness of an electron emission section formation field being 1x10 to 8 m thru/or 5x10 to 7 m.
[Claim 28] The radius of curvature of the point of the electron emission section is a cold cathode field-electron-emission component according to claim 27 characterized by being 1x10 to 9 m thru/or 1x10 to 7 m.
[Claim 29] The cathode panel by which two or more cold cathode field-electron-emission components were prepared, and the anode panel equipped with the fluorescent substance layer and the anode electrode It is the cold cathode field-electron-emission display which is joined in those periphery sections and changes. A cold cathode field-electron-emission component (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, The electron emission section formed on (c) electron emission section formation field is provided. And this electron emission section formation field It is the cold cathode field-electron-emission display characterized by consisting of a metal or metallic compounds and this electron emission section consisting of the graphite which has the crystallinity formed on this electron emission section formation field.
[Claim 30] The cathode panel by which two or more cold cathode field-electron-emission components were prepared, and the anode panel equipped with the fluorescent substance layer and the anode electrode It is the cold cathode field-electron-emission display which is joined in those periphery sections and changes. A cold cathode field-electron-emission

component (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, (c) It is arranged above the electron emission section formed on the electron emission section formation field, and (d) electron emission section, and the gate electrode which has opening is provided. This electron emission section formation field It is the cold cathode field-electron-emission display characterized by consisting of a metal or metallic compounds and this electron emission section consisting of the graphite which has the crystallinity formed on this electron emission section formation field.

[Claim 31] It is the cold cathode field-electron-emission display according to claim 29 or 30 which the average diameters of an electron emission section formation field are 1x10 to 9 m thru/or 1x10 to 7 m, and is characterized by the average thickness of an electron emission section formation field being 1x10 to 8 m thru/or 5x10 to 7 m.

[Claim 32] The radius of curvature of the point of the electron emission section is a cold cathode field-electron-emission display according to claim 31 characterized by being 1x10 to 9 m thru/or 1x10 to 7 m.

[Claim 33] The etching approach of the thin film which performs anisotropic etching to a thin film, leaves alternatively the thin film located under a particle, and is subsequently characterized by removing a particle by using this particle as the mask for etching after arranging a particle on a thin film.

[Claim 34] It is the etching approach of the thin film according to claim 33 which the average diameters of a particle are 1x10 to 9 m thru/or 1x10 to 7 m, and the average thickness of a thin film is 1x10 to 8 m thru/or 5x10 to 7 m, and is characterized by satisfying ER2 <=0.1ER1 when the etch rate of a particle [in / for the etch rate of the thin film in the direction of a normal of a thin film / ER1 and the direction of a normal of a thin film] is set to ER2.

[Claim 35] The etching approach of the thin film according to claim 33 characterized by carrying out by the approach of removing a solvent after applying the solvent which distributed the particle for arrangement of the particle to a thin film top on a thin film.

[Claim 36] The etching approach of the thin film according to claim 33 characterized by forming a thin film with chemical vapor deposition, physical vapor growth, or plating.

[Claim 37] A particle is the etching approach of the thin film according to claim 33 characterized by consisting of a silica or an alumina.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the etching approach of a thin film at electron emission equipment and its manufacture approach, a cold cathode field-electron-emission component and its manufacture approach, a cold cathode field-electron-emission indicating equipment and its manufacture approach, and a list.

[0002]

[Description of the Prior Art] If the electric field of the strength beyond a certain threshold are given to a metal, a semi-conductor, etc. which were placed into the vacuum, an electron will pass the energy barrier near the front face of a metal or a semi-conductor according to the quantum tunnel effect, and an electron will come to be emitted into a

vacuum also in ordinary temperature. the electron emission based on this principle -- cold cathode field electron emission -- or it is only called field emission (field emission). In recent years, the cold cathode field-electron-emission indicating equipment of the flat-surface mold which applied the principle of this field emission to image display, and the so-called field emission display (FED) are proposed, and it is expected from having the advantages, such as high brightness and a low power, as an image display device which replaces the conventional cathode-ray tube (CRT).

[0003] A cold cathode field-electron-emission display (it may only be hereafter called a display) has the structure where opposite arrangement of the cathode panel which generally has the electron emission section corresponding to the pixel arranged on the two-dimensional matrix, and the anode panel which is excited by the collision with the electron emitted from the electron emission section, and emits light was carried out across vacuum space. In each pixel on a cathode panel, two or more electron emission sections are formed, and the gate electrode for pulling out an electron from the electron emission section is also usually formed further. The part which has electronic the minimum structural unit about emission, i.e., the electron emission section and a gate electrode, is a cold cathode field-electron-emission component. Hereafter, a cold cathode field-electron-emission component may only be called a field emission component.

[0004] The example of a configuration of this display is shown in drawing 20 . The illustrated field emission component is a field emission component of the type called the so-called Spindt (Spindt) mold field emission component which has the electron emission section of a cone form. This field emission component consists of the electron emission sections 215 of the cone form formed on the cathode electrode 211 located in the insulating layer 212 formed on the cathode electrode 211 formed on the base material 210, and a base material 210 and the cathode electrode 211, the gate electrode 213 formed on the insulating layer 212, the opening 214 prepared in the gate electrode 213 and the insulating layer 212, and the pars basilaris ossis occipitalis of opening 214. Generally, the cathode electrode 211 and the gate electrode 213 are a field (it is equivalent to the field for 1 pixel.) equivalent to the part which the projection image of these two electrodes is respectively formed in the direction which intersects perpendicularly mutually in the shape of a stripe, and the projection image of these two electrodes overlaps. The field emission component of plurality [call / this field / hereafter / a duplication field or an electron emission field] is usually arranged. Furthermore, this duplication field is usually arranged in the shape of a two-dimensional matrix in the service area (field which functions as the actual display screen) of the cathode panel CP.

[0005] On the other hand, the anode panel AP consists of anode electrodes 33 formed on the substrate 30, the fluorescent substance layer 31 formed according to the predetermined pattern (for example, the shape of the shape of a dot, and a stripe) on the substrate 30, and the fluorescent substance layer 31. In addition, the black matrix 32 is formed on the substrate 30 between the fluorescent substance layer 31 and the fluorescent substance layer 31. 1 pixel is constituted by the duplication field of the cathode electrode 211 by the side of a cathode panel, and the gate electrode 213 by the fluorescent substance layer 31 by the side of the anode panel which met a group of the field emission component by which the predetermined number array was carried out, and a group of these field emission components. In the service area, this pixel is arranged to the order of hundreds of thousands - 1 million numbers.

[0006] A display is producible by arranging the anode panel AP and the cathode panel CP so that a field emission component and the fluorescent substance layer 31 may counter, and joining through a frame 34 in the periphery section. The cathode panel CP and the anode panel AP separate the distance of 0.1mm - about 1mm, and carry out opposite arrangement. A service area is surrounded, the through tube for evacuation (not shown) is prepared in the invalid field (for example, invalid field of the cathode panel CP) in which the circumference circuit for choosing a pixel was formed, and chip tubing (not shown) stopped after evacuation is connected to this through tube. That is, the space surrounded with the anode panel AP, the cathode panel CP, and the frame 34 serves as a vacuum.
[0007] In a field emission component, if potential difference deltaV of the electrical potential difference impressed to the gate electrode 213 and the electrical potential difference impressed to the cathode electrode 211 becomes more than a certain threshold potential deltaVth, an electron will begin to be emitted from the point of the electron emission section 215. And the emission-electron current generated by emission of the electron from the point of the electron emission section 215 increases rapidly with the increment in the electrical potential difference impressed, for example to the gate electrode 213 (namely, increment in potential difference deltaV).
[0008] A negative electrical potential difference relative to the cathode electrode 211 is impressed from the cathode electrode control circuit 40, a forward electrical potential difference relative to the gate electrode 213 is impressed from the gate electrode control circuit 41, and a forward electrical potential difference still higher than the gate electrode 213 is impressed to the anode electrode 33 from the anode electrode control circuit 42. When displaying in this display, a scan signal is inputted into the cathode electrode 211 from the cathode electrode control circuit 40, and a video signal is inputted into the gate electrode 213 from the gate electrode control circuit 41. By the electric field produced when an electrical potential difference is impressed between the cathode electrode 211 and the gate electrode 213, based on the quantum tunnel effect, an electron is emitted from the electron emission section 215, and it is drawn by this electron to the anode electrode 33, and collides with the fluorescent substance layer 31. Consequently, the fluorescent substance layer 31 is excited, light is emitted, and a desired image can be obtained. That is, actuation of this display is fundamentally controlled by the electrical potential difference impressed to the gate electrode 213, and the electrical potential difference impressed to the electron emission section 215 through the cathode electrode 211.
[0009] Hereafter, although the outline of the manufacture approach of the conventional Spindt mold field emission component is explained, fundamentally, this manufacture approach is the approach of forming the electron emission section 215 of a cone form by perpendicular vacuum evaporationo of a metallic material. That is, although incidence of the vacuum evaporationo particle is perpendicularly carried out to opening 214, the amount of the vacuum evaporationo particle which reaches the pars basilaris ossis occipitalis of opening 214 is dwindled using the shielding effect by the deposit of the shape of an overhang formed near opening 214, and the electron emission section 215 which is the deposit of a cone form is formed in self align. Hereafter, in order to make easy removal of the deposit of the shape of an unnecessary overhang, the outline of the manufacture approach of the Spindt mold field emission component based on the

approach of forming stratum disjunctum 217 beforehand on the gate electrode 213 is explained with reference to typical drawing 21 and typical drawing 22 which are end view a part, such as a base material.

[0010] [Process -10] First, after forming the cathode electrode 211 of the shape of a stripe which consists of niobium (Nb) on the base material 210 which consists of glass, the insulating layer 212 which consists of SiO2 is formed in the whole surface, and the stripe-like gate electrode 213 is further formed on an insulating layer 212. Formation of the gate electrode 213 can be performed based on a spatter, a lithography technique, and a dry etching technique.

[0011] The resist layer 216 which functions on [a process -20] next the gate electrode 213, and an insulating layer 212 as a mask for etching is formed with a lithography technique (refer to (A) of drawing 21). then, RIE (reactive ion etching) -- 1st opening 214A is formed in the gate electrode 213 in law, and this 1st opening 214A and 2nd opening 214B which was open for free passage are further formed in an insulating layer 212. In addition, the 1st opening 214A and 2nd opening 214B are generically called opening 214. The cathode electrode 211 is exposed to the pars basilaris ossis occipitalis of opening 214. Then, an ashing technique removes the resist layer 216. In this way, the structure shown in (B) of drawing 21 can be acquired.

[0012] The electron emission section 215 is formed on [a process -30], next the cathode electrode 211 exposed to the pars basilaris ossis occipitalis of opening 214. Specifically, stratum disjunctum 217 is formed in the whole surface by carrying out the slanting vacuum evaporationo of the aluminum. Stratum disjunctum 217 can be formed on the gate electrode 213 and an insulating layer 212, without making most aluminum deposit on the pars basilaris ossis occipitalis of opening 214 by choosing greatly enough the incident angle of the vacuum evaporationo particle to the normal of a base material 210 at this time. This stratum disjunctum 217 is jutted out of the open end of opening 214 in the shape of eaves, and, thereby, the diameter of opening 214 is reduced substantially (refer to (C) of drawing 21).

[0013] The perpendicular vacuum evaporationo of the molybdenum (Mo) is carried out all over [a process -40] next. Since the electrical conducting material layer 218 which consists of the molybdenum which has an overhang configuration on stratum disjunctum 217 follows on growing up and the substantial diameter of opening 214 is gradually reduced at this time as shown in (A) of drawing 22 , the vacuum evaporationo particle which contributes to deposition in the pars basilaris ossis occipitalis of opening 214 comes to be restricted to what passes through near the center of opening 214 gradually. Consequently, the deposit of a cone form is formed in the pars basilaris ossis occipitalis of opening 214, and the deposit which consists of the molybdenum of this cone form serves as the electron emission section 215.

[0014] After that [[process -50]], according to an electrochemical process and a wet process, stratum disjunctum 217 is exfoliated from the front face of an insulating layer 212 and the gate electrode 213, and an insulating layer 212 and the upper electrical conducting material layer 218 of the gate electrode 213 are removed alternatively. Consequently, as shown in (B) of drawing 22 , it can leave the electron emission section 215 of a cone form on the cathode electrode 211 located in the pars basilaris ossis occipitalis of opening 214. In addition, in the formation approach of such the electron emission section 215, the one electron emission section 215 is essentially formed in one

opening 214.
[0015] In the configuration of this display, in order to acquire a big emission-electron current by low driver voltage, it can be said that it is effective to sharpen the point of the electron emission section keenly, and the electron emission section 215 of the above-mentioned Spindt mold field emission component has the outstanding engine performance from this viewpoint. However, the point of the electron emission section 215 is about dozens of about nm, for example, 60nm, and in order to attain much more high resolution, much more radicalization of the point of the electron emission section is desired.
[0016] And formation of the electron emission section 215 of a cone form takes an advanced processing technique. Moreover, it is becoming difficult to continue throughout a service area and to form in homogeneity the electron emission section 215 which amounts to tens of millions of or more pieces depending on the case as the area of a service area increases. That is, the electrical conducting material layer 218 which covers the whole base material of a large area and has uniform membraneous quality and thickness is not formed with perpendicular vacuum deposition, or it is very difficult to form the stratum disjunctum 217 which has the eaves configuration of a uniform dimension with slanting vacuum deposition, and neither the variation within a certain field nor lot-to-lot variation is avoided. By this variation, variation arises in the image display property of an indicating equipment, for example, the brightness of an image. And in case the stratum disjunctum 217 continued and formed in the large area is removed, it becomes the cause in which the residue pollutes the cathode panel CP, and the problem of reducing the manufacture yield of a display is also produced.
[0017] Then, the so-called flat-surface mold field emission component which does not use the electron emission section of a cone form, but uses the plane electron emission section exposed to the base of opening is proposed. The electron emission section in a flat-surface mold field emission component is prepared on the cathode electrode, and even if it is a plane, it consists of ingredients with a work function lower than the component of a cathode electrode so that a high emission-electron current can be attained. As this ingredient, using a carbon system ingredient in recent years is proposed. A carbon system ingredient has low threshold electric field compared with a refractory metal, and, moreover, its electron emission effectiveness is high. Moreover, a diamond, graphite, a carbon nanotube, etc. can change a joint gestalt.
[0018] For example, the DLC (diamond-like carbon) thin film is proposed by the collection p.480 of the 59th Japan Society of Applied Physics academic lecture meeting lecture drafts, and subject number 15 p-P -13 (1998).
[0019]
[Problem(s) to be Solved by the Invention] However, the membraneous quality of a DLC thin film and the relation between structure and the electron emission characteristic have many still unknown points, and have been current and a research technical problem. Although a setup of the membrane formation conditions which manage a membrane formation reaction is important in order to control the membraneous quality of a DLC thin film and to secure high electron emission effectiveness by low threshold potential deltaVth especially, only a high value shows each threshold potential deltaVth of the DLC thin film obtained now.
[0020] The carbon material which has a low threshold potential property is proposed by

the collection p.631 of the 60th Japan Society of Applied Physics academic lecture meeting lecture drafts, and subject number 2 p-H -6 (1999) as a property of an ingredient proper to such a problem. After performing scratch processing for the titanium thin film front face formed with electron beam vacuum deposition on the quartz substrate to this reference with diamond powder, patterning of the titanium thin film is carried out to it, the gap of several micrometers is prepared in a center section, and, subsequently to a titanium thin film top, the planar structure mold electron emitter which forms a non dope diamond thin film is indicated. Or the technique which forms a carbon nanotube on the quartz glass which attached the metal crossline is indicated by the collection p.632 of the 60th Japan Society of Applied Physics academic lecture meeting lecture drafts, and subject number 2 p-H -11 (1999) again. Moreover, J.Vac.Sci.Technol.B 17(2), 674, and MAr/Apr 1999 Since the same is said of the carbon system structure which is indicated and which has the fine structure called fine crystal graphite, attention is attracted.
[0021] By the way, also in the carbon system structure which has the fine structure called a carbon nanotube and fine crystal graphite, in order to make threshold electric field still lower, it is important that it is radicalized in the part which emits an electron.
[0022] Moreover, in order to form the detailed field below the limitation of a current photolithography technique from various kinds of thin films, generally it is necessary to use an X-ray-lithography technique and an electron-beam-lithography technique. However, the equipment for applying these techniques will become large-scale.
[0023] Therefore, the 1st purpose of this invention is to provide with a cold cathode field-electron-emission display and its manufacture approach the electron emission equipment which can attain radicalization of the part which emits the electron of the electron emission section which consisted of carbon system ingredients and its manufacture approach, a cold cathode field-electron-emission component and its manufacture approach, and a list.
[0024] Moreover, the 2nd purpose of this invention is to offer the etching approach of the thin film which makes it possible to form the detailed field below the limitation of a current photolithography technique in a thin film simple, without using large-scale equipment.
[0025]
[Means for Solving the Problem] The manufacture approach of the electron emission equipment of this invention for attaining the 1st above-mentioned purpose (A) The process which forms the thin film which consists of a metal or metallic compounds on a conductor layer, (B) Anisotropic etching is performed to a thin film by using as the mask for etching the process which arranges a particle on a thin film, and (C) this particle, and it leaves alternatively the thin film located under a particle. Subsequently It is characterized by providing the process which forms the electron emission section formation field of the shape of an island which consists of the thin film which removed the particle, with was left behind, and the process which forms alternatively the electron emission section which consists of the graphite which has crystallinity on an electron emission section formation field based on (D) chemical vapor deposition.
[0026] In addition, when a conductor layer is likened with the sea as the island-like electron emission section formation field is formed on a conductor layer, an electron emission section formation field means being dotted in the shape of an island.
[0027] The manufacture approach of the cold cathode field-electron-emission component

concerning the 1st mode of this invention for attaining the 1st above-mentioned purpose is the manufacture approach of the cold cathode field-electron-emission component which constitutes 2 so-called electrode types of cold cathode field-electron-emission display. Namely, the manufacture approach of the cold cathode field-electron-emission component concerning the 1st mode of this invention (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, And the process which is the manufacture approach of a cold cathode field-electron-emission component of providing the electron emission section formed on (c) electron emission section formation field, and forms a cathode electrode on the (A) base material, (B) The process which forms the thin film which consists of a metal or metallic compounds on a cathode electrode, (C) Anisotropic etching is performed to a thin film by using as the mask for etching the process which arranges a particle on a thin film, and (D) this particle, and it leaves alternatively the thin film located under a particle. Subsequently It is characterized by providing the process which forms the electron emission section formation field of the shape of an island which consists of the thin film which removed the particle, with was left behind, and the process which forms alternatively the electron emission section which consists of the graphite which has crystallinity on an electron emission section formation field based on (E) chemical vapor deposition.

[0028] In addition, when a cathode electrode is likened with the sea as the island-like electron emission section formation field is formed on a cathode electrode, an electron emission section formation field means being dotted in the shape of an island.

[0029] The manufacture approach of the cold cathode field-electron-emission component concerning the 2nd mode of this invention for attaining the 1st above-mentioned purpose is the manufacture approach of the cold cathode field-electron-emission component which constitutes 3 so-called electrode types of cold cathode field-electron-emission display. Namely, the manufacture approach of the cold cathode field-electron-emission component concerning the 2nd mode of this invention (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, (c) It is arranged above the electron emission section formed on the electron emission section formation field, and (d) electron emission section. The process which is the manufacture approach of a cold cathode field-electron-emission component of providing the gate electrode which has opening, and forms a cathode electrode on the (A) base material, (B) The process which forms the thin film which consists of a metal or metallic compounds on a cathode electrode, (C) Anisotropic etching is performed to a thin film by using as the mask for etching the process which arranges a particle on a thin film, and (D) this particle, and it leaves alternatively the thin film located under a particle. Subsequently It is characterized by providing the process which forms the electron emission section formation field of the shape of an island which consists of the thin film which removed the particle, with was left behind, and the process which forms alternatively the electron emission section which consists of the graphite which has crystallinity on an electron emission section formation field based on (E) chemical vapor deposition.

[0030] The manufacture approach of the cold cathode field-electron-emission display concerning the 1st mode of this invention for attaining the 1st above-mentioned purpose is the manufacture approach of 2 so-called electrode types of cold cathode field-electron-

emission display. Namely, the manufacture approach of the cold cathode field-electron-emission display concerning the 1st mode of this invention The cathode panel by which two or more cold cathode field-electron-emission components were prepared, and the anode panel equipped with the fluorescent substance layer and the anode electrode It is joined in those periphery sections and changes. A cold cathode field-electron-emission component (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, And the process which is the manufacture approach of a cold cathode field-electron-emission display of providing the electron emission section formed on (c) electron emission section formation field, and forms a cathode electrode on the (A) base material, (B) The process which forms the thin film which consists of a metal or metallic compounds on a cathode electrode, (C) Anisotropic etching is performed to a thin film by using as the mask for etching the process which arranges a particle on a thin film, and (D) this particle, and it leaves alternatively the thin film located under a particle. Subsequently It is characterized by providing the process which forms the electron emission section formation field of the shape of an island which consists of the thin film which removed the particle, with was left behind, and the process which forms alternatively the electron emission section which consists of the graphite which has crystallinity on an electron emission section formation field based on (E) chemical vapor deposition.

[0031] The manufacture approach of the cold cathode field-electron-emission display concerning the 2nd mode of this invention for attaining the 1st above-mentioned purpose is the manufacture approach of 3 so-called electrode types of cold cathode field-electron-emission display. Namely, the manufacture approach of the cold cathode field-electron-emission display concerning the 2nd mode of this invention The cathode panel by which two or more cold cathode field-electron-emission components were prepared, and the anode panel equipped with the fluorescent substance layer and the anode electrode It is joined in those periphery sections and changes. A cold cathode field-electron-emission component (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, (c) It is arranged above the electron emission section formed on the electron emission section formation field, and (d) electron emission section. The process which is the manufacture approach of a cold cathode field-electron-emission display of providing the gate electrode which has opening, and forms a cathode electrode on the (A) base material, (B) The process which forms the thin film which consists of a metal or metallic compounds on a cathode electrode, (C) Anisotropic etching is performed to a thin film by using as the mask for etching the process which arranges a particle on a thin film, and (D) this particle, and it leaves alternatively the thin film located under a particle. Subsequently It is characterized by providing the process which forms the electron emission section formation field of the shape of an island which consists of the thin film which removed the particle, with was left behind, and the process which forms alternatively the electron emission section which consists of the graphite which has crystallinity on an electron emission section formation field based on (E) chemical vapor deposition.

[0032] If it is in the manufacture approach of the cold cathode field-electron-emission display concerning the manufacture approach of the cold cathode field-electron-emission

component concerning the 2nd mode of this invention, or the 2nd mode of this invention An insulating layer is formed in the whole surface after said process (E), subsequently the gate electrode which has opening is formed, further, the 2nd opening can be formed in an insulating layer and the process which exposes the electron emission section at the pars basilaris ossis occipitalis of the 2nd opening can be considered as the configuration provided further. In addition, such a configuration is called for convenience the manufacture approach of the 2nd A of this invention.

[0033] Or if it is in the manufacture approach of the cold cathode field-electron-emission display applied to the manufacture approach of the cold cathode field-electron-emission component concerning the 2nd mode of this invention, or the 2nd mode of this invention again An insulating layer is formed in the whole surface after said process (B), subsequently the gate electrode which has opening is formed, further, the 2nd opening can be formed in an insulating layer and the process which exposes a thin film at the pars basilaris ossis occipitalis of the 2nd opening can be considered as the configuration provided further. In addition, such a configuration is called for convenience the manufacture approach of the 2nd B of this invention.

[0034] Or if it is in the manufacture approach of the cold cathode field-electron-emission display applied to the manufacture approach of the cold cathode field-electron-emission component concerning the 2nd mode of this invention, or the 2nd mode of this invention again An insulating layer is formed in the whole surface after said process (D), subsequently the gate electrode which has opening is formed, further, the 2nd opening can be formed in an insulating layer and the process which exposes a cathode electrode and an electron emission section formation field at the pars basilaris ossis occipitalis of the 2nd opening can be considered as the configuration provided further. In addition, such a configuration is called for convenience the manufacture approach of the 2nd C of this invention.

[0035] Or if it is in the manufacture approach of the cold cathode field-electron-emission display applied to the manufacture approach of the cold cathode field-electron-emission component concerning the 2nd mode of this invention, or the 2nd mode of this invention again An insulating layer is formed in the whole surface after said process (A), subsequently the gate electrode which has opening is formed, further, the 2nd opening can be formed in an insulating layer and the process which exposes a cathode electrode at the pars basilaris ossis occipitalis of the 2nd opening can be considered as the configuration provided further. In addition, such a configuration is called for convenience the manufacture approach of the 2nd D of this invention.

[0036] In the manufacture approach of the 2nd D of this invention, although it is dependent also on the formation approach of a thin film After a process (B) forms in the center section of the pars basilaris ossis occipitalis of the 2nd opening the mask layer which the front face of a cathode electrode exposed (After [namely,] forming a mask layer in the side attachment wall of the 2nd opening at least), it can consider as the configuration which consists of the process which forms a thin film on a mask layer including the front face of the exposed cathode electrode. After formation of this mask layer applies for example, a resist ingredient layer to the whole surface, it can be performed based on a lithography technique by the approach of forming a pore in the resist ingredient layer located in the center section of the pars basilaris ossis occipitalis of the 2nd opening. Since some cathode electrodes located in the pars basilaris ossis

occipitalis of the 2nd opening, the side attachment wall of the 2nd opening, the side attachment wall of the 1st opening, and a gate electrode form a thin film in the front face of the cathode electrode located in the center section of the pars basilaris ossis occipitalis of the 2nd opening in the condition of having been covered with the mask layer, a cathode electrode and a gate electrode can prevent connecting too hastily with a thin film certainly. The upper chisel of a gate electrode may be covered with a mask layer depending on the case. Or the upper chisel of the gate electrode near [which was established in the gate electrode] the 1st opening may be covered with a mask layer again, and the side attachment wall of the gate electrode top near the 1st opening and the 1st opening, and the 2nd opening may be covered with a mask layer. Although the electron emission section may be formed on a gate electrode depending on the electrical conducting material and CVD conditions which constitute a gate electrode in these cases, if this electron emission section is not placed into the electric field of high intensity, an electron is not emitted from this electron emission section. In addition, it is desirable to remove a mask layer in one before activation of a process (E) of processes.
[0037] Or if it is in the manufacture approach of the cold cathode field-electron-emission display applied to the manufacture approach of the cold cathode field-electron-emission component concerning the 2nd mode of this invention, or the 2nd mode of this invention again As an approach of forming a cold cathode field-electron-emission component, the gate electrode supporter of the shape of band-like [which consists of an insulating material], or parallel crosses is formed on a base material. Subsequently So that the gate electrode which consists of the band-like ingredient with which two or more openings were formed may touch the top face of a gate electrode supporter, after performing said process (A) - a process (E) And the approach (it may be hereafter called the manufacture approach of the 2nd E) of consisting of the process which lays a band-like ingredient is also employable so that opening may be located above the electron emission section.
[0038] the field or two or more cathode electrodes between the cathode electrodes of the shape of a stripe which adjoins each other in a gate electrode supporter if it is in the manufacture approach of the 2nd E -- a group -- what is necessary is just to form in the field between adjacent cathode electrode groups, when it considers as a cathode electrode group As an ingredient which constitutes a gate electrode supporter, a well-known insulating material can be used conventionally, for example, the insulating material of SiO2 grade can be used. As the formation approach of a gate electrode supporter, a CVD method, the combination of the etching method and screen printing, the sandblasting method, the dry film method, and the exposing method can be illustrated. The dry film method is the approach of embedding the insulating material for gate electrode supporter formation, and calcinating to opening which removed the photographic sensitive film of the part which should laminate a photographic sensitive film and should form a gate electrode supporter by exposure and development on a base material, and was produced by removal. It is burned and removed by baking, the insulating material for gate electrode supporter formation embedded at opening remains, and a photographic sensitive film serves as a gate electrode supporter. After the exposing method forms the insulating material for gate electrode supporter formation which has photosensitivity on a base material and carries out patterning of this insulating material by exposure and development, it is an approach of performing baking.
[0039] The manufacture approach of the cold cathode field-electron-emission component

concerning the 1st mode or 2nd mode including the manufacture approach of the electron emission equipment of this invention, and various gestalten, If it is in the manufacture approach (these may only be hereafter called the manufacture approach of this invention generically) of the cold cathode field-electron-emission display concerning the 1st mode or 2nd mode including various gestalten Or they are 1x10 to 9 m thru/or 1x10 to 8 m preferably 1x10 to 7 m. the average diameter of a particle -- 1x10 to 9 m -- Or they are 1x10 to 8 m thru/or 1x10 to 7 m preferably 5x10 to 7 m. the average thickness of a thin film -- 1x10 to 8 m -- When the etch rate of a particle [in / for the etch rate of the thin film in the direction of a normal of a thin film / ER1 and the direction of a normal of a thin film] is set to ER2, it is desirable ER2 <=0.1ER1 and to satisfy ER2 <=0.01ER1 preferably. ER2 <=0.1ER1 can be satisfied by choosing suitably the ingredient which constitutes a particle and a thin film, and setting up etching conditions appropriately. In addition, it is desirable to set the radius of curvature of the point of the obtained electron emission section to 1x10 to 9 m thru/or 1x10<SUP>-7m.
[0040] In the manufacture approach of this invention, after applying the solvent which distributed the particle for arrangement of the particle to a thin film top on a thin film, it is desirable to carry out by the approach of removing a solvent from a viewpoint of arranging a particle to homogeneity as much as possible to up to the ease of a configuration method, simple nature, and a thin film. Moreover, it is desirable to form a thin film in chemical vapor deposition (CVD method) or physical vapor growth (PVD), or to form it with plating (for electrolysis plating and an electroless deposition method to be included) again from a viewpoint that the homogeneous thin film which has uniform thickness can be formed easily. In addition, as for a particle, it is desirable to consist of the silica containing colloidal silica or an alumina, copper oxide, a silver oxide, and gold. Moreover, it is desirable from a viewpoint of achievement of anisotropic etching to perform etching based on the etching method physical etching by ion irradiation and the chemical etching by the chemical reaction of a radical were put together. here -- as PVD -- various spatters, such as various vacuum deposition methods, such as a ** electron-beam-heating method, a resistance heating method, and flash plate vacuum evaporationo, ** plasma vacuum deposition, a ** 2 pole spatter, a direct-current spatter, the direct-current magnetron sputtering method, a high-frequency spatter, the magnetron sputtering method, the ion beam spatter method, and the bias spatter method, and ** DC (direct current) -- the various ion-plating methods, such as law, the RF method, a multi-cathode method, the activation reacting method, electric-field vacuum deposition, the high-frequency ion-plating method, and the reactant ion-plating method, can be mentioned.
[0041] The electron emission equipment of this invention for attaining the 1st above-mentioned purpose is characterized by having the electron emission section which consists of the graphite which has the crystallinity formed on the electron emission section formation field of the shape of an island which consists of the metal or metallic compounds formed on (a) conductor layer, and (b) this electron emission section formation field.
[0042] By the electron emission equipment or its manufacture approach of this invention, the source of an electron ray in the electron gun built into the electron emission section, cathode-ray tube, and scanning electron microscope of a cold cathode field-electron-emission component and a fluorescent indicator tube can be obtained.
[0043] The cold cathode field-electron-emission component concerning the 1st mode of

this invention for attaining the 1st above-mentioned purpose is a cold cathode field-electron-emission component which constitutes 2 so-called electrode types of cold cathode field-electron-emission display. Namely, the cold cathode field-electron-emission component concerning the 1st mode of this invention (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, It is a cold cathode field-electron-emission component possessing the electron emission section formed on (c) electron emission section formation field. And this electron emission section formation field It consists of a metal or metallic compounds, and this electron emission section is characterized by consisting of the graphite which has the crystallinity formed on this electron emission section formation field.

[0044] The cold cathode field-electron-emission component concerning the 2nd mode of this invention for attaining the 1st above-mentioned purpose is a cold cathode field-electron-emission component which constitutes 3 so-called electrode types of cold cathode field-electron-emission display. Namely, the cold cathode field-electron-emission component concerning the 2nd mode of this invention (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, (c) It is arranged above the electron emission section formed on the electron emission section formation field, and (d) electron emission section. It is a cold cathode field-electron-emission component possessing the gate electrode which has opening, and this electron emission section formation field consists of a metal or metallic compounds, and this electron emission section is characterized by consisting of the graphite which has the crystallinity formed on this electron emission section formation field.

[0045] The cold cathode field-electron-emission display concerning the 1st mode of this invention for attaining the 1st above-mentioned purpose is 2 so-called electrode types of cold cathode field-electron-emission display. Namely, the cold cathode field-electron-emission display concerning the 1st mode of this invention The cathode panel by which two or more cold cathode field-electron-emission components were prepared, and the anode panel equipped with the fluorescent substance layer and the anode electrode It is the cold cathode field-electron-emission display which is joined in those periphery sections and changes. A cold cathode field-electron-emission component (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, And the electron emission section formed on (c) electron emission section formation field is provided, this electron emission section formation field consists of a metal or metallic compounds, and this electron emission section is characterized by consisting of the graphite which has the crystallinity formed on this electron emission section formation field.

[0046] In addition, if shown in the cold cathode field-electron-emission display concerning the 1st mode of this invention, based on the electric field formed with the anode electrode, based on the quantum tunnel effect, an electron is emitted from the electron emission section, and it is drawn by this electron to an anode electrode, and collides with a fluorescent substance layer. The electrical conducting material sheet of one sheet may have wrap structure for the service area, and the anode electrode may have the stripe configuration. In the case of the former, actuation of the electron emission section is controlled for every electron emission section which constitutes 1 pixel. For

that purpose, what is necessary is just to prepare a switching element between the electron emission sections and the cathode electrode control circuits which constitute 1 pixel, for example. In the case of the latter, a cathode electrode is made into the shape of a stripe, and a cathode electrode and an anode electrode are arranged so that the projection image of an anode electrode and the projection image of a cathode electrode may intersect perpendicularly. An electron is emitted from two or more electron emission sections located in the field (it is hereafter called an anode electrode / cathode electrode duplication field) to which the projection image of an anode electrode and the projection image of a cathode electrode overlap. In addition, fundamentally, the array of the cold cathode field-electron-emission component in 1 anode electrode / cathode electrode duplication field is random. The drive of such a cold cathode field-electron-emission display of a configuration is performed by the so-called passive matrix. That is, a negative electrical potential difference is impressed relatively [electrode / cathode], and a forward electrical potential difference is impressed relatively [electrode / anode]. Consequently, an electron is alternatively emitted to throughout [vacuum sky] from the electron-emission section located in an anode electrode / cathode electrode duplication field with the anode electrode (or anode electrode by which train selection was made with the cathode electrode by which line selection was made) by which line selection was made with the cathode electrode by which train selection was made, and it collides with the fluorescent substance layer from which it is drawn by this electron to an anode electrode, and it constitutes an anode panel, and a fluorescent substance layer excites and makes emit light.

[0047] The cold cathode field-electron-emission display concerning the 2nd mode of this invention for attaining the 1st above-mentioned purpose is 3 so-called electrode types of cold cathode field-electron-emission display. Namely, the cold cathode field-electron-emission display concerning the 2nd mode of this invention The cathode panel by which two or more cold cathode field-electron-emission components were prepared, and the anode panel equipped with the fluorescent substance layer and the anode electrode It is the cold cathode field-electron-emission display which is joined in those periphery sections and changes. A cold cathode field-electron-emission component (a) The electron emission section formation field of the shape of an island formed on the cathode electrode prepared on the base material, and (b) cathode electrode, (c) It is arranged above the electron emission section formed on the electron emission section formation field, and (d) electron emission section, and the gate electrode which has opening is provided. This electron emission section formation field It consists of a metal or metallic compounds, and this electron emission section is characterized by consisting of the graphite which has the crystallinity formed on this electron emission section formation field.

[0048] the 2nd voice of this invention -- if shown in the cold cathode field-electron-emission display applied like, it is desirable from a viewpoint of the simplification of the structure of a cold cathode field-electron-emission display to have extended in the direction in which the projection image of a stripe-like gate electrode and the projection image of a stripe-like cathode electrode intersect perpendicularly. In addition, two or more cold cathode field-electron-emission components are prepared in the duplication field (it is an electron emission field and is equivalent to the field for 1 pixel, or the field for 1 subpixel) to which the projection image of a stripe-like cathode electrode and a

stripe-like gate electrode overlaps, and this duplication field (a gate electrode / cathode electrode duplication field) is usually arranged in the shape of a two-dimensional matrix in the service area (field which functions as a part for an actual display) of a cathode panel. In addition, fundamentally, the array of the cold cathode field-electron-emission component in 1 duplication field is random. A negative electrical potential difference is impressed relatively [electrode / cathode], a forward electrical potential difference is impressed relatively [electrode / gate], and a forward electrical potential difference still higher than a gate electrode is impressed to an anode electrode. An electron is alternatively emitted to throughout [vacuum sky] from two or more electron-emission sections located in a gate electrode / a cathode electrode duplication field with the gate electrode (or gate electrode by which train selection was made with the cathode electrode by which line selection was made) by which line selection was made with the cathode electrode by which train selection was made, and it collides with the fluorescent substance layer from which it is drawn by this electron to an anode electrode, and it constitutes an anode panel, and a fluorescent substance layer excites and makes emit light.

[0049] The cold cathode field-electron-emission component concerning the electron emission equipment, the 1st mode, or the 2nd mode of this invention, Or it sets again to the cold cathode field-electron-emission display concerning the 1st mode or 2nd mode of this invention. The average diameter of an electron emission section formation field 1x10 to 9 m thru/or 1x10 to 7 m, It is 1x10 to 9 m thru/or 1x10 to 8 m preferably, and, as for the average thickness of an electron emission section formation field, it is desirable 1x10 to 8 m thru/or that they are 1x10 to 8 m thru/or 1x10 to 7 m preferably 5x10 to 7 m. In addition, as for the radius of curvature of the point of the obtained electron emission section, it is desirable 1x10 to 9 m thru/or that they are 1x10 to 9 m thru/or 1x10 to 8 m preferably 1x10 to 7 m.

[0050] If it is in the cold cathode field-electron-emission component in the cold cathode field-electron-emission display concerning the 2nd mode of the cold cathode field-electron-emission component concerning the 2nd mode of this invention, or this invention An insulating layer is formed on a base material and a cathode electrode, and the gate electrode which has opening is formed on this insulating layer. To this insulating layer It can consider as the structure which the electron emission section has exposed to the pars basilaris ossis occipitalis of the 2nd opening which the 2nd opening which was open for free passage to opening prepared in the gate electrode was formed, and was formed in the insulating layer. In addition, such a configuration is called for convenience the cold cathode field-electron-emission component which has the 1st structure. Hereafter, opening prepared in the gate electrode may be called the 1st opening for convenience. The cold cathode field-electron-emission component which has the 1st structure may be based on the manufacture approach of the 2nd A of this invention, the manufacture approach of the 2nd B, the manufacture approach of the 2nd C, or the manufacture approach of the 2nd D.

[0051] Or if it is in the cold cathode field-electron-emission component in the cold cathode field-electron-emission display applied to the 2nd mode of the cold cathode field-electron-emission component concerning the 2nd mode of this invention, or this invention again The gate electrode which consists of the band-like ingredient with which the gate electrode supporter of the shape of band-like [which consists of an insulating

material], or parallel crosses was formed on the base material, and two or more openings were formed so that the top face of a gate electrode supporter may be touched And it can also consider as the structure laid so that opening might be located above the electron emission section. In addition, such a configuration is called for convenience the cold cathode field-electron-emission component which has the 2nd structure. The cold cathode field-electron-emission component which has this 2nd structure may be based on the manufacture approach of the 2nd E of this invention.

[0052] If it is in the manufacture approach of this invention, it is desirable as material gas in the CVD method for forming the electron emission section to use the combination of hydrocarbon system gas and hydrogen gas. Here, the gas which evaporated hydrocarbon system gas, such as methane (CH4), ethane (C2H6), a propane (C3H8), butane (C4H10), ethylene (C2H4), and acetylene (C2H2), these mixed gas, a methanol, ethanol, an acetone, benzene, toluene, a xylene, naphthalene, etc. can be mentioned as hydrocarbon system gas. Moreover, in order to carry out discharge to stability, and in order to promote plasma dissociation, the gas for dilution, such as helium (helium) and an argon (Ar), may be mixed, and doping gas, such as nitrogen and ammonia, may be mixed. Moreover, when using the combination of hydrocarbon system gas and hydrogen gas, it is desirable 1% thru/or to make preferably the flow rate of hydrocarbon system gas and the hydrocarbon system gas to the full flow of hydrogen gas into 5% thru/or 50% 50%. Here, hydrogen gas plays the role which removes the graphite crystal grain child who is not good among the formed graphite crystal grain children as for crystallinity (a kind of etching).

[0053] If it is in the CVD method for forming the electron emission section Where bias voltage is impressed to a base material, a plasma consistency More than 1016m-3 (107mm-3) It is [more than 1017m-3 (108mm-3)] preferably desirable to be based on the plasma-CVD method of the conditions more than 1019m-3 (1010mm-3) much more preferably from a viewpoint of making high the degree of dissociation of the material gas used for electron emission section formation, and forming the electron emission section certainly. Or the CVD method for forming the electron emission section is desirable again from a viewpoint of being in the condition which impressed bias voltage to the base material, and electron temperature making high 1 thru/or the degree of dissociation of the material gas which 5eV thru/or 15eV, and an ion current consistency use for 0.1 mA/cm2 thru/or 30 mA/cm2, and 15eV of things preferably based on the plasma-CVD method of the conditions of 5 mA/cm2 thru/or 30 mA/cm2 uses for electron emission section formation preferably, and forming the electron emission section certainly. And a microwave plasma-CVD method, a transformer coupling mold plasma-CVD method, an inductive-coupling mold plasma-CVD method, a electron cyclotron resonance plasma-CVD method, a helicon wave plasma-CVD method, a capacity-coupling mold plasma-CVD method, and DC plasma-CVD method can be mentioned as a plasma-CVD method in these cases. Or a hot filament CVD method may be adopted again. A heat CVD method may be adopted depending on the case. In addition, whenever [in the process which forms the electron emission section / base material stoving temperature] can be preferably made below into 300-degreeC much more preferably below 400-degreeC still more preferably below 500-degreeC below 600-degreeC. The minimum of whenever [base material stoving temperature] should just be taken as the temperature which can form the electron emission section.

[0054] The cold cathode field-electron-emission component concerning the 1st mode or 2nd mode of the electron emission equipment of this invention or its manufacture approach, and this invention, or its manufacture approach, The cold cathode field-electron-emission display concerning the 1st mode or 2nd mode of this invention, or its manufacture approach (these are hereafter named generically) The graphite which has the crystallinity which only the case where it is called this invention can set for it to be It consists of graphite which has sp2 association, and they are the monolayer carbon nanotube which has the structure where the carbon graphite sheet of one layer was rolled, or the so-called carbon nanotube which has the structure where the carbon graphite sheet more than two-layer was rolled. Or it consists of what amorphous carbon deposited on the perimeter of the carbon nano fiber with which the carbon graphite sheet lapped, and a carbon nanotube or a carbon nano fiber again (adhesion). The carbon atom which has sp2 association usually constitutes a six membered ring from six carbon atoms, and the assembly of these six membered rings constitutes a carbon graphite sheet. It is the carbon nanotube which has the tube structure around which this carbon graphite sheet was wound. It is the carbon nano fiber which a carbon graphite sheet was not rolled, but the fragmentation of carbon graphite lapped on the other hand, and became fiber-like. Depending on the case, it may also have a conic configuration. It is dependent on the ingredient which constitutes CVD conditions, a thin film, or an electron emission section formation field what kind of structure the electron emission section becomes. The electron emission section which consisted of one carbon nanotube, the electron emission section which consisted of one carbon nano fiber, or the electron emission section which has one conic configuration again is formed in one electron emission section formation field. In other words, the aggregate (a graphite crystal grain child's aggregate) of the graphite which has one crystallinity is widely formed on one electron emission section formation field. Moreover, the electron emission section is alternatively formed on an electron emission section formation field, and is not formed on a conductor layer or a cathode electrode.
[0055] As an ingredient which constitutes the thin film or electron emission section formation field in this invention Nickel (nickel), molybdenum (Mo), titanium (Ti), chromium (Cr), Cobalt (Co), a tungsten (W), a zirconium (Zr), a tantalum (Ta), Iron (Fe), copper (Cu), platinum (Pt), zinc (Zn), germanium (germanium), Tin (Sn), lead (Pb), a bismuth (Bi), silver (Ag), gold (Au), Although at least one kind of metal chosen from the group which consists of an indium (In), manganese (Mn), palladium (Pd), and a thallium (Tl) or the metallic compounds containing these elements, and an alloy can be mentioned It is desirable to use nickel, Mo, Ti, Co, Fe, Pt, Zn, Pb, Pd or the metallic compounds containing these elements, and an alloy especially. Furthermore, the metal metallurgy group compound and alloy which have a catalysis in the ambient atmosphere when forming the electron emission section (composition) also except the metal mentioned above can be used.
[0056] As a solvent in the manufacture approach of this invention, or the etching approach of the thin film of this invention mentioned later, pure water, ethyl alcohol, isopropyl alcohol, and an acetone can be illustrated. Moreover, a spin coat method can be illustrated as an approach of applying the solvent which distributed the particle on a thin film. It is also possible to adopt screen printing depending on the case. What is necessary is just to dry in the temperature to which a solvent evaporates, in order to remove a

solvent.
[0057] If it is in the manufacture approach of this invention, or the etching approach of the thin film of this invention mentioned later, as the removal approach of a particle, a thin film, a particle, etc. can be immersed [whole] in pure water, ethyl alcohol, isopropyl alcohol, an acetone, etc., and the approach of performing ultrasonic cleaning can be mentioned. Or the approach immersed [whole] in the liquid which dissolves a particle again depending on the ingredient which constitutes a particle in a thin film, a particle, etc., and the method of burning a particle can be illustrated.
[0058] In the cold cathode field-electron-emission component which has the 1st structure The 1st opening and 2nd opening which were prepared in the gate electrode good also as correspondence relation of one to one -- carrying out (namely, the 1st one opening -- corresponding -- the 2nd one opening -- you preparing) -- many pairs -- good (that is, the 2nd one opening may be prepared corresponding to much 1st opening) also as correspondence relation of 1.
[0059] In the cold cathode field-electron-emission display concerning the 2nd mode of the cold cathode field-electron-emission component concerning the 2nd mode of this invention, or this invention An electron emission section formation field or an electron emission section formation field, and the electron emission section Are [that what is necessary is to just be formed in the front face of the cathode electrode located in the pars basilaris ossis occipitalis of the 2nd opening] dependent on the manufacture approach of a cold cathode field-electron-emission component. It may be formed so that it may extend into the part of the cathode electrode covered with insulating layers other than the pars basilaris ossis occipitalis of the 2nd opening from the part of the cathode electrode located in the pars basilaris ossis occipitalis of the 2nd opening.
[0060] As an approach of forming the gate electrode which has the 1st opening on an insulating layer in the manufacture approach of the manufacture approach of the 2nd A - the 2nd D After forming the electrical conducting material layer for constituting a gate electrode on an insulating layer, the 1st mask ingredient layer by which patterning was carried out is formed on an electrical conducting material layer. After carrying out patterning of the electrical conducting material layer by etching an electrical conducting material layer, using this 1st mask ingredient layer as a mask for etching, the 1st mask ingredient layer is removed. Subsequently The 2nd mask ingredient layer by which patterning was carried out is formed on an electrical conducting material layer and an insulating layer. The approach of etching an electrical conducting material layer, using this 2nd mask ingredient layer as a mask for etching, and forming the 1st opening or the approach of forming directly the gate electrode which has the 1st opening with screen printing again can be illustrated. The approach of forming in an insulating layer the 2nd opening which is open for free passage to the 1st opening prepared in the gate electrode in these cases is good also as an approach of etching an insulating layer, using this 2nd mask ingredient layer as a mask for etching, and good also as an approach of etching an insulating layer, using the 1st opening prepared in the gate electrode as a mask for etching. in addition, the 1st opening and 2nd opening are good also as correspondence relation of one to one -- carrying out (namely, the 1st one opening -- corresponding -- the 2nd one opening -- you forming) -- many pairs -- good (that is, the 2nd one opening may be formed corresponding to much 1st opening) also as correspondence relation of 1. Furthermore, the process which prepares the gate electrode which has opening may

constitute a gate electrode from a band-like band-like ingredient layer in which two or more openings were formed, and may lay a band-like ingredient layer on an insulating layer. Isotropic etching (isotropic etching of the part of the insulating layer which specifically constitutes the side-attachment-wall side of the 2nd opening), the dry etching which uses a radical as a main etching kind like chemical dry etching, or the wet etching using an etching reagent can perform formation of the 2nd opening.
[0061] In order to make selective growth of the electron emission section on an electron emission section formation field into a much more positive thing, it is desirable to remove the oxide (the so-called natural oxidation film) of the front face of an electron emission section formation field. It is desirable to perform removal of an oxide by washing processing using the acids and bases in for example, a hydrogen gas ambient atmosphere or an ammonia gas ambient atmosphere, such as plasma reduction processing based on the microwave plasma method, the transformer coupling mold plasma method, the inductive-coupling mold plasma method, the electron cyclotron resonance plasma method, the RF plasma method, etc., spatter processing in an argon gas ambient atmosphere, or fluoric acid. In addition, also when producing the electron emission equipment of this invention, the various processes explained above can be applied to the front face of the part of the conductor layer which should form an electron emission section formation field.
[0062] In the cold cathode field-electron-emission component concerning the 1st mode of this invention, cold cathode field-electron-emission displays, or these manufacture approaches, it is desirable to make the appearance configuration of a cathode electrode into the shape of a rectangle or a stripe. It is desirable to make the appearance configuration of a gate electrode into the shape of a stripe, and to, make the appearance configuration of a cathode electrode into the shape of a stripe on the other hand, in the cold cathode field-electron-emission component concerning the 2nd mode of this invention, cold cathode field-electron-emission displays, or these manufacture approaches. The directions where a stripe-like cathode electrode and a stripe-like gate electrode are prolonged differ. As for the projection image of a stripe-like cathode electrode, and the projection image of a stripe-like gate electrode, intersecting perpendicularly mutually is desirable. In addition, two or more electron emission sections are located in the field (it is equivalent to the field for 1 pixel, and is the duplication field of a cathode electrode and a gate electrode) equivalent to the part which the projection image of these two electrodes overlaps. Furthermore, this duplication field is usually arranged in the shape of a two-dimensional matrix in the service area (field which functions as the actual display screen) of a cathode panel. Fundamentally, the array of the cold cathode field-electron-emission component in 1 pixel is random.
[0063] In the cold cathode field-electron-emission component which has the 2nd structure, or its manufacture approach, the flat-surface configuration (configuration when cutting these openings at a virtual flat surface parallel to a cathode electrode) of the 1st opening or the 2nd opening can make the configuration of arbitration circular, an ellipse form, a rectangle, a polygon, roundish [wore], roundish [wore], etc.
[0064] As structure of a cathode electrode, it can also consider as 1 lamination of an electrical conducting material layer, and can also consider as 3 lamination of the upper electrical conducting material layer formed on the lower layer electrical conducting material layer, the resistor layer formed on the lower layer electrical conducting material

layer, and the resistor layer. In the case of the latter, an electron emission section formation field is formed in the front face of the upper electrical conducting material layer. Or a cathode electrode can also be considered as the two-layer configuration of the resistor layer formed on the electrical conducting material layer and the electrical conducting material layer again. Thus, equalization of the electron emission characteristic of the electron emission section can be attained by preparing a resistor layer. As an ingredient which constitutes a resistor layer, refractory metal oxides, such as semiconductor materials, such as a carbon system ingredient called silicon carbide (SiC), SiN, and an amorphous silicon, ruthenium oxide (RuO2), tantalum oxide, and tantalum nitride, can be illustrated. As the formation approach of a resistor layer, the sputtering method, a CVD method, and screen printing can be illustrated. What is necessary is just to set preferably 1x105 to 1x107 ohms of resistance to several M omega in general.
[0065] If it is in the manufacture approach of the cold cathode field-electron-emission display concerning the manufacture approach of the cold cathode field-electron-emission component concerning the 2nd mode of this invention, and the 2nd mode of this invention After forming the gate electrode which has the shape of a stripe on an insulating layer, the 2nd insulating layer is formed on an insulating layer and a gate electrode, and the convergence electrode which has a pore is formed on this 2nd insulating layer. Subsequently After forming the 3rd opening in the 2nd insulating layer, it is good also as a configuration which forms the 1st opening in a gate electrode and forms the 2nd opening in an insulating layer further. The cold cathode field-electron-emission component which starts the 2nd mode of this invention which has a convergence electrode by this, or the cold cathode field-electron-emission component which has a convergence electrode in the cold cathode field-electron-emission display concerning the 2nd mode of this invention again can be obtained.
[0066] Here, a convergence electrode is an electrode for completing the orbit of the emission electron which is emitted from the 1st opening and faces to an anode electrode, with enabling improvement in brightness, and prevention of the optical cross talk between contiguity pixels. The potential difference between an anode electrode and a cathode electrode is the order which is several kilovolts, and especially a convergence electrode has an effective distance between an anode electrode and a cathode electrode in the so-called high-voltage type of comparatively long cold cathode field-electron-emission display. A relative negative electrical potential difference is impressed to a convergence electrode from a convergence power source. A convergence electrode can also do a funneling effect common to two or more cold cathode field-electron-emission components by necessarily not being prepared for every cold cathode field-electron-emission component, for example, making it extend along the predetermined array direction of a cold cathode field-electron-emission component.
[0067] In the cold cathode field-electron-emission component or its manufacture approach of this invention a base material Although a glass substrate, the glass substrate with which the insulator layer was formed in the front face, a quartz substrate, the quartz substrate with which the insulator layer was formed in the front face, and the semi-conductor substrate with which the insulator layer was formed in the front face can be mentioned that the front face should just consist of insulating members at least It is desirable from a viewpoint of manufacture cost reduction to use a glass substrate and the glass substrate with which the insulator layer was formed in the front face especially. A

substrate as well as a base material can be constituted. What is necessary is for this base material just to consist of insulating materials also in the electron emission equipment of this invention, although it is necessary to form a conductor layer on a base material.

[0068] As an ingredient which constitutes a conductor layer, a cathode electrode, a gate electrode, or a convergence electrode A tungsten (W), niobium (Nb), a tantalum (Ta), molybdenum (Mo), metals, such as chromium (Cr), aluminum (aluminum), and copper (Cu), the alloy containing these metallic elements, or a compound (for example, nitrides, such as TiN, --) Semi-conductors, such as silicide of WSi2, MoSi2, TiSi2, and TaSi2 grade or silicon (Si), and ITO (indium stannic acid ghost) can be illustrated. In addition, it is mutually good also as an ingredient of the same kind in the ingredient which constitutes these electrodes, and good also as an ingredient of a different kind. As the formation approach of these electrodes, vacuum deposition, a spatter, a CVD method, the ion plating method, screen printing, plating, etc. can use the usual thin film production process.

[0069] In addition, it is desirable that the ingredient which constitutes a gate electrode or a convergence electrode, and the ingredient which constitutes a thin film or an electron emission section formation field are different ingredients from a viewpoint of not making the electron emission section form on a gate electrode or a convergence electrode. Or a polish recon layer and an insulator layer may be formed on a gate electrode or a convergence electrode again from a viewpoint of not making the electron emission section form on a gate electrode or a convergence electrode. Or what is necessary is just to form a gate electrode or a convergence electrode from an ingredient with which graphite is not formed again in the CVD conditions when forming the electron emission section with a CVD method. Moreover, in order to form the electron emission section alternatively on an electron emission section formation field (i.e., in order not to make the electron emission section form on a conductor layer or a cathode electrode), it is necessary to form a conductor layer and a cathode electrode from an ingredient with which graphite is not formed in the CVD conditions when forming the electron emission section with a CVD method.

[0070] independent [in SiO2, SiN, SiON, and a glass paste hardened material] as a component of an insulating layer or the 2nd insulating layer -- or it can be used, combining suitably. Well-known processes, such as a CVD method, the applying method, a spatter, and screen printing, can be used for formation of an insulating layer.

[0071] What is necessary is just to choose the component of an anode electrode by the configuration of a cold cathode field-electron-emission display. That is, a cold cathode field-electron-emission display is a transparency mold (an anode panel is equivalent to the screen), and when the laminating of an anode electrode and the fluorescent substance layer is carried out to this order on the substrate, from origin, the substrate of the anode electrode itself with which an anode electrode is formed needs to be transparent, and uses transparence electrical conducting materials, such as ITO (indium stannic acid ghost). On the other hand, when a cold cathode field-electron-emission display is a reflective mold (a cathode panel is equivalent to the screen), and when [even if it is a transparency mold,] the laminating of a fluorescent substance layer and the anode electrode is carried out to this order on the substrate (the anode electrode serves as the metal back film), the ingredient mentioned above in relation to an others and cathode electrode and a gate electrode, or the convergence electrode can be chosen suitably, and can be used. [ITO]

[0072] As a fluorescent substance which constitutes a fluorescent substance layer, the fluorescent substance for high-speed electronic excitation and the fluorescent substance for low-speed electronic excitation can be used. When a cold cathode field-electron-emission display is monochromatic specification equipment, patterning especially of the fluorescent substance layer does not have to be carried out. Moreover, when a cold cathode field-electron-emission display is a electrochromatic display, it is desirable to arrange by turns the red (R) and green (G) by which patterning was carried out to the shape of the shape of a stripe and a dot, and the fluorescent substance layer corresponding to blue (B) three primary colors. In addition, the clearance between the fluorescent substance layers by which patterning was carried out may be embedded by the black matrix aiming at the improvement in contrast of a display screen.
[0073] The configuration which forms a fluorescent substance layer on the configuration which forms an anode electrode on (1) substrate and forms a fluorescent substance layer on an anode electrode, and (2) substrates, and forms an anode electrode on a fluorescent substance layer as an example of a configuration of an anode electrode and a fluorescent substance layer can be mentioned. In addition, in the configuration of (1), the so-called metal back film electrically connected with the anode electrode on the fluorescent substance layer may be formed. Moreover, in the configuration of (2), the metal back film may be formed on an anode electrode.
[0074] It is good also as an anode electrode of the format which covered the service area with the electrical conducting material of the shape of a sheet of one sheet depending on the configuration of a cold cathode field-electron-emission display, and an anode electrode is good also as an anode electrode of a format with which 1, two or more electron emission sections, 1, or the anode electrode units corresponding to two or more pixels gathered, and good also as a stripe-like anode electrode.
[0075] the 1st mode of this invention, and the 2nd voice -- in the manufacture approach of the cold cathode field-electron-emission display applied like, when joining a substrate and a base material in the periphery section, you may carry out by using together the frame and glue line which may perform junction using a glue line or consist of insulating rigidity ingredients, such as glass and a ceramic. When using a frame and a glue line together, compared with the case where only a glue line is used, it is possible by choosing the height of a frame suitably to set up the opposite distance between a substrate and a base material for a long time. In addition, as a component of a glue line, although frit glass is common, the melting point may use the so-called 120-400-degree low-melt point point metallic material it is [metallic material] about C. As this low-melt point point metallic material, low-melting-alloys;Sn80Ag20 (the melting point C of 220-370 degrees) of an Indium: Melting point (C) In[of 157 degrees]; indium-golden system, (Tin Sn) system elevated-temperature solder, such as Sn95Cu5 (the melting point C of 227-370 degrees) ;P b97.5Ag2.5 (the melting point C of 304 degrees), (Zinc Zn) system elevated-temperature solder;Sn5Pb(s)95 (the melting point C of 300-314 degrees), such as lead (Pb) system elevated-temperature solder;Zn95aluminum5 (the melting point C of 380 degrees), such as Pb94.5Ag5.5 (the melting point C of 304-365 degrees), and Pb97.5Ag1.5Sn1.0 (the melting point C of 309 degrees), Tin-lead system standard solder, such as Sn2Pb98 (the melting point C of 316-322 degrees); wax material (all the above subscripts express atomic %), such as Au88Ga12 (the melting point C of 381 degrees), can be illustrated.

[0076] When joining three persons of a substrate, a base material, and a frame, 3 person coincidence junction may be performed, or a substrate, or either and the frame of a base material may be joined first in the 1st step, and a substrate, or another side and the frame of a base material may be joined in the 2nd step. If 3 person coincidence junction and junction in the 2nd step are performed in a high vacuum ambient atmosphere, the space surrounded by the substrate, the base material, the frame, and the glue line will serve as a vacuum at junction and coincidence. Or the space surrounded by the substrate, the base material, the frame, and the glue line can be exhausted after three persons' junction termination, and it can also consider as a vacuum. When exhausting after junction, the pressures of the ambient atmosphere at the time of junction may be any of ordinary pressure/reduced pressure, and the gas which constitutes an ambient atmosphere may be inert gas containing the gas (for example, Ar gas) belonging to nitrogen gas or periodic table 0 group, even if it is atmospheric air.
[0077] When exhausting after junction, exhaust air can be performed through chip tubing beforehand connected to the substrate and/or the base material. Chip tubing is typically constituted using a glass tube, and after using frit glass or an above-mentioned low-melt point point metallic material, being joined and space's reaching a predetermined degree of vacuum, it has been confined in the perimeter of a through tube established in the substrate and/or the invalid field (namely, fields other than the service area which functions as the display screen) of a base material by thermal melting arrival. In addition, if the temperature is made to lower before performing the stop end once it heats the whole display, since residual gas can be made to be able to emit to space and exhaust air can remove this residual gas out of space, it is suitable.
[0078] After the etching approach of the thin film of this invention for attaining the 2nd above-mentioned purpose arranges a particle on a thin film, by using this particle as the mask for etching, it performs anisotropic etching to a thin film, leaves alternatively the thin film located under a particle, and, subsequently is characterized by removing a particle.
[0079] If it is in the etching approach of the thin film of this invention, after applying the solvent which distributed the particle for arrangement of the particle to a thin film top on a thin film, it is desirable to carry out by the approach of removing a solvent. Moreover, it is desirable to form a thin film with a CVD method, the PVD illustrated previously, or plating (for electrolysis plating and an electroless deposition method to be included). As for a particle, it is desirable to consist of the silica or alumina containing colloidal silica. Furthermore, it is desirable from a viewpoint of achievement of anisotropic etching to perform etching based on the etching method physical etching by ion irradiation and the chemical etching by the chemical reaction of a radical were put together. in addition -- as the average diameter of a particle -- 1x10 to 9 m thru/or 1x10 to 7 m -- desirable -- 1x10 to 9 m thru/or 1x10 to 8 m -- it can illustrate -- a thin film -- average thickness -- ** -- carrying out -- 1x10 to 8 m -- or 1x10 to 8 m thru/or 1x10 to 7 m can be illustrated preferably 5x10 to 7 m. Moreover, when the etch rate of a particle [in / for the etch rate of the thin film in the direction of a normal of a thin film / ER1 and the direction of a normal of a thin film] is set to ER2, it is desirable ER2 <=0.1ER1 and to satisfy ER2 <=0.01ER1 preferably. ER2 <=0.1ER1 can be satisfied by choosing suitably the ingredient which constitutes a particle and a thin film, and setting up etching conditions appropriately.

[0080] In the etching approach of the thin film of this invention, the thin film is formed on the base. Here, the ingredient which constitutes a base and a thin film is essentially arbitrary. Moreover, Field of application of the etching approach of the thin film of this invention is also essentially arbitrary.
[0081] As a result of being able to obtain a detailed electron emission section formation field by choosing the path of a particle as the electron emission equipment of this invention and its manufacture approach, a cold cathode field-electron-emission component and its manufacture approach, and a list appropriately in a cold cathode field-electron-emission display and its manufacture approach, the electron emission section with the detailed (thin) part which emits an electron can be obtained. Moreover, according to the etching approach of the thin film of this invention, the detailed field below the limitation of the present photolithography technique can be formed in a thin film by choosing the path of a particle appropriately.
[0082]
[Embodiment of the Invention] Hereafter, with reference to a drawing, this invention is explained based on the gestalt (it is hereafter called the gestalt of operation for short) of implementation of invention.
[0083] (Gestalt 1 of operation) the gestalt 1 of operation -- the electron emission equipment of this invention and its manufacture approach, and the 1st voice -- the cold cathode field-electron-emission component (it is hereafter called a field emission component for short) which starts like and its manufacture approach, and the 1st voice -- it is related with the etching approach of the thin film of this invention at 2 so-called electrode types applied like of cold cathode field-electron-emission display (it is hereafter called a display for short) and its manufacture approach, and a list.
[0084] some typical displays of the gestalt 1 of operation -- a sectional view -- drawing 1 -- being shown -- a part of one typical field emission component -- a sectional view is shown in (D) of drawing 2 . In addition, in the drawing, although the electron emission section was displayed regularly, it is formed in the random location in fact. Also in other drawings, it is the same.
[0085] The electron-emission equipment in the gestalt 1 of operation is equipped with the electron-emission section 15 which consists of the graphite (carbon nanotube which specifically consisted of graphite which has sp2 association) which has the crystallinity formed on the electron-emission section formation field 22 of the shape of an island which consists of the metal (it sets in the gestalt 1 of operation and is specifically nickel) formed on the conductor layer, and the electron-emission section formation field 22.
[0086] Moreover, the field emission component in the gestalt 1 of operation possesses the electron emission section 15 formed on the cathode electrode 11 prepared on the base material 10, the electron emission section formation field 22 of the shape of an island formed on the cathode electrode 11, and the electron emission section formation field 22. That is, when the cathode electrode 11 (or conductor layer) is likened with the sea, it is dotted with the electron emission section formation field 22 in the shape of an island. And the electron emission section formation field 22 consists of a metal (it sets in the gestalt 1 of operation and, specifically, is nickel), and the electron emission section 15 consists of graphite (carbon nanotube which specifically consisted of graphite which has sp2 association) which has the crystallinity formed on the electron emission section formation field 22. The flat-surface configuration of the cathode electrode 11 is a stripe

configuration. Furthermore, the cathode panel CP by which two or more field emission components were prepared, and the anode panel AP equipped with the fluorescent substance layer 31 (green luminescence fluorescent substance layer 31 red luminescence fluorescent substance layer 31R, G and blue luminescence fluorescent substance layer 31B) and the anode electrode 33 are joined in those periphery sections, and the display in the gestalt 1 of operation changes, and has two or more pixels. The anode electrode 33 is a stripe-like. The projection image of the stripe-like cathode electrode 11 and the projection image of the stripe-like anode electrode 33 intersect perpendicularly. The cathode electrode 11 was prolonged to the space perpendicular direction of drawing 1 R> 1, and, specifically, the anode electrode 33 is prolonged in the space longitudinal direction of drawing 1 . In the cathode panel CP in the display of the gestalt 1 of operation, many electron emission fields which consisted of plurality of the above field emission components are formed in the service area in the shape of a two-dimensional matrix.

[0087] The through tube for evacuation (not shown) is prepared in the invalid field of the cathode panel CP, and chip tubing (not shown) stopped after evacuation is connected to this through tube. A frame 34 consists of the ceramics or glass, and height is 1.0mm. Depending on the case, only a glue line can also be used instead of a frame 34.

[0088] Specifically, the anode panel AP consists of anode electrodes 33 of the shape of a stripe which consists of a wrap, for example, an aluminum thin film, in the substrate 30, the fluorescent substance layer 31 which was formed on the substrate 30 and formed according to the predetermined pattern (for example, the shape of the shape of a stripe, or a dot), and the fluorescent substance layer 31. The black matrix 32 is formed on the substrate 30 between the fluorescent substance layer 31 and the fluorescent substance layer 31. In addition, the black matrix 32 is also omissible. Moreover, when monochromatic specification equipment is assumed, the fluorescent substance layer 31 does not necessarily need to be formed according to a predetermined pattern. Furthermore, the anode electrode which consists of transparence electric conduction film, such as ITO, may be prepared between a substrate 30 and the fluorescent substance layer 31. Or the anode electrode 33 which consists of the transparence electric conduction film prepared on the substrate 30, It can consist of the aluminum formed on the fluorescent substance layer 31 and the black matrix 32 which were formed on the anode electrode 33, and the fluorescent substance layer 31 and the black matrix 32, and can also constitute from light reflex electric conduction film electrically connected with the anode electrode 33.

[0089] 1 pixel is constituted by the fluorescent substance layer 31 arranged in the service area of the anode panel AP so that a cathode panel side might be met at the stripe-like cathode electrode 11, the electron emission section 15 formed on it, and the electron emission section 15. In the service area, this pixel is arranged to the order of hundreds of thousands - 1 million numbers.

[0090] Moreover, the spacer 35 is arranged at equal intervals in the service area as a supplementary means for maintaining the distance between both panels uniformly between the cathode panel CP and the anode panel AP. In addition, the configuration of a spacer 35 may be spherical, for example not only a cylindrical shape but, and may be a stripe-like septum (rib). Moreover, the spacer 35 does not necessarily need to be arranged in the four corners of the duplication field of all cathode electrodes, and may be arranged

more at the non-dense, and its arrangement may be irregular.

[0091] In this display, based on the electric field formed with the anode electrode 33, based on the quantum tunnel effect, an electron is emitted from the electron emission section 15, and it is drawn by this electron to the anode electrode 33, and collides with the fluorescent substance layer 31. That is, the drive of a display is performed by the so-called passive matrix to which an electron is emitted from the electron emission section 15 located in the field (an anode electrode / cathode electrode duplication field) to which the projection image of the anode electrode 33 and the projection image of the cathode electrode 11 overlap. A negative electrical potential difference is impressed relatively [electrode / 11 / cathode] from the cathode electrode control circuit 40, and, specifically, a forward electrical potential difference is impressed relatively [electrode / 33 / anode] from the anode electrode control circuit 42. Consequently, the anode electrode 33 () by which line selection was made with the cathode electrode 11 by which train selection was made Or an electron is alternatively emitted to throughout [vacuum sky] from the electron emission section 15 located in an anode electrode / cathode electrode duplication field with the anode electrode 33 by which train selection was made with the cathode electrode 11 by which line selection was made. It collides with the fluorescent substance layer 31 from which it is drawn by this electron to the anode electrode 33, and it constitutes the anode panel AP, and the fluorescent substance layer 31 is excited and is made to emit light.

[0092] Hereafter, the electron emission equipment in the gestalt 1 of operation, a field emission component and the manufacture approach of an indicating equipment, and the etching approach of a thin film are explained with reference to typical drawing 3 which is sectional views a part, such as typical drawing 2 R> 2 which is sectional views a part, such as a base material, and a substrate.

[0093] [Process -100] The cathode electrode 11 is first formed on a base material 10. Specifically, the mask layer which consists of a resist ingredient is formed on the base material 10 which consists of a glass substrate. A mask layer is formed so that base materials 10 other than the part which should form a stripe-like cathode electrode may be covered. Subsequently, the conductor layer which consists of Cr, aluminum, Mo, or Ta is formed on the whole surface in a spatter. Then, the stripe-like cathode electrode 11 can be formed by removing the conductor layer on it in a mask layer list. The cathode electrode 11 is prolonged in the space longitudinal direction of drawing 2 . In addition, it may replace with such a lift-off method, and the stripe-like cathode electrode 11 may be formed by membrane formation of the conductor layer which constitutes a cathode electrode, and patterning of a conductor layer based on a lithography technique and a dry etching technique.

[0094] After forming in the whole surface in a spatter the thin film 20 with an average thickness of 10nm which consists of nickel (nickel) after that [[process -110]], patterning which leaves the part of the thin film 20 which should form the electron emission section is performed based on a lithography technique and an etching technique. In this way, the structure shown in (A) of drawing 2 can be acquired.

[0095] A particle 21 is arranged on a thin film 20 after that [[process -120]]. It dries and a solvent is removed, after applying to the whole surface the solution which made the solvent which consists of isopropyl alcohol specifically distribute colloidal silica with a mean particle diameter of 10nm with a spin coat method. In this way, the condition which

shows in (B) of drawing 2 can be acquired. The arrangement consistency of the particle 21 on a thin film 20 is controllable by the amount of the particle in a solution. In addition, it distributes in a solvent, and since it is hard to produce condensation of particles and colloidal silica is excellent in dispersibility after it serving as colloid and arranging it on a thin film 20 (spreading), it distributes colloidal silica by the comparatively uniform consistency on a thin film 20. Moreover, it excels also in the homogeneity of the particle size in the inside of a solvent.

[0096] After that [[process -130]], anisotropic etching is performed to a thin film 20 by using a particle 21 as the mask for etching, and it leaves alternatively the thin film 20 located under a particle 21. reactive ion etching (RIE) specifically illustrated to Table 1 of the following which is the etching method physical etching by ion irradiation and the chemical etching by the chemical reaction of a radical were put together -- it leaves alternatively the thin film 20 which etches a thin film 20 by using a particle 21 as the mask for etching, and is located under a particle 21 in law (refer to (C) of drawing 2 R> 2). Subsequently, the electron emission section formation field 22 of the shape of an island which removes a particle 21 and consists of the left-behind thin film 20 is formed. For example, a particle 21 is removable by immersing the whole base material in isopropyl alcohol, and performing ultrasonic cleaning. In addition, if it is in the conditions shown in Table 1, when the etch rate of the particle [in / for the etch rate of the thin film 20 in the direction of a normal of a thin film 20 / ER1 and the direction of a normal of a thin film 20] 21 is set to ER2, ER2**0.1ER1 is satisfied.

[0097] [Table 1]

etching system: -- parallel monotonous RIE system etching gas: -- Cl2=100SCCM pressure : 0.4PaRF power : 1-2kW (13.56MHz)

Etching temperature: 400-500-degreeC [0098] The electron emission section 15 which consists of the graphite which has crystallinity is alternatively formed on the electron emission section formation field 22 by the microwave plasma-CVD method after that [[process -140]]. The formation conditions of the electron emission section 15 are illustrated to the following table 2. In this way, as shown in (D) of drawing 2 , a field emission component or electron emission equipment can be obtained.

[0099] [Table 2]

Material gas :CH4/H2=50 / 50sccm pressure : 2Pa microwave power: 3kW base material temperature : 400-degreeC plasma consistency : 1x1012-/cm3 electron temperature : 10eV ion current consistency : 20 mA/cm2 [0100] The assembly of a display is performed after that [[process -150]]. The anode panel AP and the cathode panel CP are specifically arranged so that the fluorescent substance layer 31 and a field emission component may counter, and the anode panel AP and the cathode panel CP (specifically, they are a substrate 30 and a base material 10) are joined in the periphery section through a frame 34. After applying frit glass at least to the joint of a frame 34, about a joint with the anode panel AP and a frame 34, and the cathode panel CP and drying frit glass for the anode panel AP, the cathode panel CP, and a frame 34 by lamination and preliminary baking on the occasion of junction, this baking for 10 - 30 minutes is performed by about 450-degreeC. Then, the space surrounded with the anode panel AP, the cathode panel CP, a frame 34, and frit glass is exhausted through a through tube (not shown) and chip tubing (not shown), and when the pressure of space amounts to about 10 - 4Pa, heating melting has stopped chip tubing. Thus, space surrounded by the anode panel AP, the

cathode panel CP, and the frame 34 can be made into a vacuum. Then, wiring with a required external circuit is performed and a display is completed.

[0101] When the obtained electron emission section 15 was observed with the scanning electron microscope, the electron emission section 15 consists of carbon nanotubes the diameter of about 10nm and whose radius of curvatures of a point are the averages of about 5nm, and it was observed that the carbon nanotube is prolonged in the shape of a column toward the upper part from the top face of the electron emission section formation field 22. When the electron emission characteristic from the obtained display was evaluated, the electron emission from the whole display surface has been checked. In addition, threshold potential deltaVth of this display was about 50% of threshold potential deltaVth in the display incorporating the conventional Spindt mold field emission component.

[0102] In addition, an example of the manufacture approach of the anode panel AP in the display shown in drawing 1 is hereafter explained with reference to drawing 3 .

[0103] First, a luminescent crystal grain child constituent is prepared. Therefore, for example, pure water is made to distribute a dispersant and churning is performed for 1 minute in 3000rpm using a homomixer. Next, it supplies in the pure water with which the dispersant distributed the luminescent crystal grain child, and churning is performed for 5 minutes in 5000rpm using a homomixer. Then, for example, polyvinyl alcohol and an ammonium dichromate are added, and it fully agitates and filters.

[0104] In manufacture of the anode panel AP, the photosensitive coat 50 is formed the whole surface on the substrate 30 which consists, for example of glass (spreading). And it is injected from the exposure light source (not shown), and by the ultraviolet rays which passed the pore 54 prepared in the mask 53, the photosensitive coat 50 formed on the substrate 30 is exposed, and the sensitization field 51 is formed (refer to (A) of drawing 3). Then, the photosensitive coat 50 is developed, and it removes alternatively, and leaves the remainder (photosensitive coat after exposure and development) 52 of a photosensitive coat on a substrate 30 (refer to (B) of drawing 3). Next, a carbon agent (carbon slurry) is applied to the whole surface, after drying and calcinating, by removing the remainder 52 of a photosensitive coat, and the carbon agent on it by the lift-off method, the black matrix 32 which consists of a carbon agent is formed on the exposed substrate 30, it combines, and the remainder 52 of a photosensitive coat is removed (refer to (C) of drawing 3). Then, red, green, and each blue fluorescent substance layer 31 are formed on the exposed substrate 30 (refer to (D) of drawing 3 R> 3). The luminescent crystal grain child constituent prepared from each luminescent crystal grain child (fluorescent substance particle) is specifically used, for example, a luminescent photosensitive red crystal grain child constituent (fluorescent substance slurry) is applied to the whole surface, and is exposed and developed. Subsequently What is necessary is to apply a luminescent photosensitive green crystal grain child constituent (fluorescent substance slurry) to the whole surface, to expose and develop it, to apply to the whole surface, to expose and just to develop a luminescent, photosensitive, still bluer crystal grain child constituent (fluorescent substance slurry). Then, the anode electrode 33 (it has a stripe configuration) which consists of an aluminum thin film with a thickness of about 0.07 micrometers in a spatter is formed on the fluorescent substance layer 31 and the black matrix 32. In addition, each fluorescent substance layer 31 can also be formed with screen printing etc.

[0105] In addition, the fluorescent substance layer 31 arranged in the service area of the anode panel AP so that a cathode panel side might be met at the cathode electrode 11 of a rectangle configuration, the electron emission section 15 formed on it, and the electron emission section 15 may constitute 1 pixel. The typical perspective view of the cathode electrode 11 in the one electron emission section in this case is shown in drawing 4 . In such a display, it is a 1-pixel unit and the electrical potential difference impressed to the cathode electrode 11 is controlled. As the flat-surface configuration of the cathode electrode 11 is typically shown in drawing 4 , it is an abbreviation rectangle and each cathode electrode 11 is connected to the cathode electrode control circuit 40 through wiring 11A and the switching element (not shown) which consists of a transistor. Moreover, the anode electrode 33 is connected to the anode electrode control circuit 42. As for the anode electrode 33, the electrical conducting material sheet of one sheet should just have wrap structure for the service area. It is good also as an anode electrode of a format with which 1, two or more electron emission sections, 1, or the anode electrode units corresponding to two or more pixels gathered depending on the case. If the electrical potential difference more than threshold voltage is impressed to each cathode electrode 11, based on the electric field formed with the anode electrode 33, based on the quantum tunnel effect, an electron will be emitted from the electron emission section 15, and it will be drawn by this electron to the anode electrode 33, and will collide with the fluorescent substance layer 31. Brightness is controlled by the electrical potential difference impressed to the cathode electrode 11.
[0106] If in charge of manufacture of the field emission component of such structure, in [a process -100], the conductor layer for cathode electrode formation is formed on the base material 10 which consists of a silicon semi-conductor substrate. Subsequently, based on a well-known lithography technique and a well-known reactive-ion-etching method (the RIE method), the cathode electrode 11 of a rectangle configuration is formed on a base material 10 by carrying out patterning of the conductor layer. Wiring 11A (refer to drawing 4) connected to the cathode electrode 11 at coincidence is formed on a base material 10. Then, a field emission component can be obtained by performing [process -110] - [a process -140], and a display can be further obtained by performing [a process -150].
[0107] (Gestalt 2 of operation) The gestalt 2 of operation is deformation of the gestalt 1 of operation. If it is in the manufacture approach explained with the gestalt 1 of operation, natural oxidation of the front face of the electron emission section formation field 22 is carried out, and formation of the electron emission section 15 may become difficult. In the gestalt 2 of operation, the metallic oxide (the so-called natural oxidation film) of the front face of the electron emission section formation field 22 is removed. In addition, plasma reduction processing or washing processing removes the metallic oxide of the front face of the electron emission section formation field 22.
[0108] Since the structure of the electron emission equipment manufactured according to the gestalt 2 of operation, a field emission component, and a display is the same as the structure of the electron emission equipment explained with the gestalt 1 of operation, a field emission component, and a display, detailed explanation is omitted. Hereafter, the manufacture approach of the field emission component of the gestalt 2 operation and the manufacture approach of a display are explained.
[0109] [Process -200] The same process as [process -100] - [a process -130] is performed

first. [of the gestalt 1 of operation]
[0110] The metallic oxide (natural oxidation film) of the front face of [a process -210], next the electron emission section formation field 22 is removed based on the plasma reduction processing (microwave plasma treatment) illustrated to the following table 3. Or the metallic oxide (natural oxidation film) of the front face of the electron emission section formation field 22 exposed using a fluoric acid water solution and 1:49 (volume ratio) mixed liquor of pure water 50% is also removable again.
[0111] [Table 3]
Gas used : H2=100SCCM pressure : 1.3x103Pa microwave power: 600W (13.56MHz) Processing temperature : 400-degreeC [0112] After that [[process -220]], the [process -140] of the gestalt 1 of operation and the same process are performed, a field emission component is manufactured, and the assembly of a display is further performed like the [process -150] of the gestalt 1 of operation. In addition, the electron emission section 15 which consists of the graphite which has crystallinity is alternatively formed on the electron emission section formation field 22 by the microwave plasma-CVD method.
[0113] In the gestalt 2 of operation, since the electron emission section 15 is formed in the front face of this electron emission section formation field 22 after removing the metallic oxide (natural oxidation film) of the front face of the electron emission section formation field 22, formation of the electron emission section 15 in still lower temperature is attained.
[0114] (Gestalt 3 of operation) The gestalt 3 of operation is related with the thin film of this invention in 3 so-called electrode types concerning the field emission component concerning the electron emission equipment of this invention and its manufacture approach, and the 2nd mode and its manufacture approach (the manufacture approach of the 2nd A), and the 2nd mode of indicating equipment and its manufacture approach, and a list at the etching approach. In addition, the field emission component in the gestalt 3 of operation has the 1st structure.
[0115] a part of typical field emission component of the gestalt 3 of operation -- end view -- drawing 8 -- being shown -- some typical displays -- end view is shown in drawing 5 and the typical partial perspective view when disassembling the cathode panel CP and the anode panel AP is shown in drawing 6 . This field emission component is arranged above the electron emission section 15 formed on the electron emission section formation field 22 of the shape of an island formed on the cathode electrode 11 (it is equivalent to a conductor layer) formed on the base material 10, and the cathode electrode 11, and the electron emission section formation field 22, and the electron emission section 15, and possesses the gate electrode 13 which has opening 14A. In addition, opening 14A prepared in the gate electrode 13 is called 1st opening 14A for convenience. And the insulating layer 12 is formed on the base material 10 and the cathode electrode 11, 2nd opening 14B which was open for free passage to 1st opening 14A prepared in the gate electrode 13 is prepared in the insulating layer 12, and the electron emission section 15 is located in the pars basilaris ossis occipitalis of 2nd opening 14B.
[0116] The above field emission components consist of the cathode panels CP and the anode panels AP which were formed in the service area, a display consists of two or more pixels, and each pixel consists of the anode electrodes 33 and the fluorescent substance layers 31 which countered the field emission component and the field emission component, and were prepared on the substrate 30. The cathode panel CP and the anode

panel AP are joined through the frame 34 in those periphery sections. It is as [which is shown in drawing 5] not limiting to this, although Openings 14A and 14B and the electron emission section 15 are shown in end view per cathode electrode 11 in the cathode panel CP for [two / every] the simplification of a drawing, and the fundamental configuration of a field emission component having been shown in drawing 8 the part, and. Furthermore, the through tube 36 for evacuation is formed in the invalid field of the cathode panel CP, and the chip tubing 37 stopped after evacuation is connected to this through tube 36. However, drawing 5 shows the completion condition of an indicating equipment, and the illustrated chip tubing 37 has already been stopped. Moreover, illustration of a spacer was omitted.
[0117] Since structure of the anode panel AP can be made into the same structure as the anode panel AP explained with the gestalt 1 of operation, detailed explanation is omitted. However, as for the anode electrode 33, the electrical conducting material sheet of one sheet has wrap structure for the service area.
[0118] When displaying in this display, a negative electrical potential difference relative to the cathode electrode 11 is impressed from the cathode electrode control circuit 40, a forward electrical potential difference relative to the gate electrode 13 is impressed from the gate electrode control circuit 41, and a forward electrical potential difference still higher than the gate electrode 13 is impressed to the anode electrode 33 from the anode electrode control circuit 42. When displaying in this display, a scan signal is inputted into the cathode electrode 11 from the cathode electrode control circuit 40, and a video signal is inputted into the gate electrode 13 from the gate electrode control circuit 41. In addition, contrary to this, a video signal may be inputted into the cathode electrode 11 from the cathode electrode control circuit 40, and a scan signal may be inputted into the gate electrode 13 from the gate electrode control circuit 41. By the electric field produced when an electrical potential difference is impressed between the cathode electrode 11 and the gate electrode 13, based on the quantum tunnel effect, an electron is emitted from the electron emission section 15, and it is drawn by this electron to the anode electrode 33, and collides with the fluorescent substance layer 31. Consequently, the fluorescent substance layer 31 is excited, light is emitted, and a desired image can be obtained.
[0119] Hereafter, the manufacture approach of the electron emission equipment of the gestalt 3 operation, the manufacture approach (the manufacture approach of the 2nd A) of a field emission component, and the manufacture approach of a display are explained with reference to typical drawing 7 and typical drawing 8 which are end view a part, such as a base material.
[0120] [Process -300] The electron emission section 15 which consists of the graphite which has crystallinity can be first formed alternatively with a CVD method on the [process -100] electron emission section formation field 22 of the gestalt 1 of operation formed on the cathode electrode 11 by performing the same process as - [a process -140]. In addition, in [a process -110] and the same process, patterning of a thin film 20 is unnecessary, or good in a line again based on a lithography technique and an etching technique. [patterning / which leaves a thin film 20 all over the cathode electrode 11 depending on the case] Or it may replace with [a process -100] and [a process -110], and the following processes may be performed again. That is, the mask layer which consists of a resist ingredient is formed on the base material 10 which consists of a glass substrate. It forms so that base materials 10 other than the part which should form a stripe-like

cathode electrode for a mask layer may be covered. Subsequently, a conductor layer and a thin film are formed on the whole surface one by one in a spatter. Then, the laminated structure of the stripe-like cathode electrode 11 and a thin film 20 can be obtained by removing the thin film and conductor layer on it in a mask layer list. Such a process is also included by the process which forms a cathode electrode on a base material, and the process which forms the thin film which consists of a metal or metallic compounds on a cathode electrode.

[0121] Specifically, an insulating layer 12 is formed all over [a process -310] next on a base material 10, the cathode electrode 11, and the electron emission section 15 (refer to (A) of drawing 7). Specifically, the insulating layer 12 with a thickness of about 3 micrometers is formed in the whole surface with the CVD method which uses TEOS (tetra-ethoxy silane) as material gas. In addition, for example, an insulating layer 12 may be formed with a spatter or screen printing. Then, the gate electrode 13 which has 1st opening 14A is formed on an insulating layer 12. After forming the mask ingredient layer (not shown) by which patterning was carried out on an electrical conducting material layer after specifically forming in a spatter the electrical conducting material layer (it is the same ingredient as the ingredient which constitutes the cathode electrode 11) for constituting a gate electrode on an insulating layer 12, etching an electrical conducting material layer, using this mask ingredient layer as a mask for etching and carrying out patterning of the electrical conducting material layer to the shape of a stripe, a mask ingredient layer is removed. Subsequently, the resist ingredient layer by which patterning was carried out is formed on an electrical conducting material layer and an insulating layer 12, and an electrical conducting material layer is etched, using this resist ingredient layer as a mask for etching. By this, the gate electrode 13 which has 1st opening 14A on an insulating layer 12 can be obtained. The stripe-like gate electrode 13 is prolonged in the different direction (for example, drawing 7 R> 7 and the space perpendicular direction of drawing 8) from the cathode electrode 11. Then, 2nd opening 14B which is open for free passage to 1st opening 14A formed in the gate electrode 13 is formed in an insulating layer 12. Specifically, an insulating layer 12 is etched by the RIE method, using a resist ingredient layer as a mask for etching. In this way, the structure shown in (B) of drawing 7 can be acquired. In the gestalt 3 of operation, 1st opening 14A and 2nd opening 14B have the correspondence relation of one to one. That is, corresponding to opening 14of ** one 1st A, opening 14of ** one 2nd B is formed. In addition, the flat-surface configuration of the 1st and 2nd openings 14A and 14B is a round shape with a diameter of 1 micrometer - 30 micrometers. What is necessary is just to form these openings 14A and 14B in 1 one - pixels [about 3000].

[0122] It is desirable to retreat the side-attachment-wall side of 2nd opening 14B established in the insulating layer 12 by isotropic etching after that [[process -320]] from a viewpoint of exposing the open end of the gate electrode 13. In this way, the field emission component shown in drawing 8 can be completed. In addition, the dry etching which uses a radical as a main etching kind like chemical dry etching, or the wet etching using an etching reagent can perform isotropic etching. As an etching reagent, a fluoric acid water solution and 1:100 (volume ratio) mixed liquor of pure water can be used 49%, for example.

[0123] The assembly of a display is performed like the [process -150] of the gestalt 1 of operation after that [[process -330]].

[0124] When the obtained electron emission section 15 was observed with the scanning electron microscope, the electron emission section 15 consists of carbon nanotubes the diameter of about 10nm and whose radius of curvatures of a point are the averages of about 5nm, and it was observed that the carbon nanotube is prolonged in the shape of a column toward the upper part from the top face of the electron emission section formation field 22. When the electron emission characteristic from the obtained display was evaluated, the electron emission from the whole display surface has been checked. In addition, threshold potential deltaVth of this display was about 50% of threshold potential deltaVth in the display incorporating the conventional Spindt mold field emission component.
[0125] In addition, the electron emission section formation field 22 and the electron emission section 15 may be formed so that it may extend into the part of the cathode electrode 11 covered with insulating layers 12 other than the pars basilaris ossis occipitalis of 2nd opening 14B from the part of the cathode electrode 11 located in the pars basilaris ossis occipitalis of 2nd opening 14B depending on the case that what is necessary is to just be formed in the front face of the cathode electrode 11 located in the pars basilaris ossis occipitalis of 2nd opening 14B.
[0126] Moreover, the approach of removing the metallic oxide (the so-called natural oxidation film) of the front face of the electron emission section formation field 22 explained with the gestalt 2 of operation is also applicable to the gestalt 3 of operation. Also in the gestalt of the operation explained below, it is the same.
[0127] (Gestalt 4 of operation) The gestalt 4 of operation is deformation of the gestalt 3 of operation, and is related with the manufacture approach of the 2nd B. In addition, the field emission component in the gestalt 4 of operation also has the 1st structure.
[0128] Since the display of the gestalt 4 of operation has the same structure as the display of the gestalt 3 of operation, detailed explanation is omitted. Hereafter, the manufacture approach of the electron emission equipment of the gestalt 4 operation, the manufacture approach (the manufacture approach of the 2nd B) of a field emission component, and the manufacture approach of a display are explained with reference to typical <u>drawing 9</u> and typical <u>drawing 10</u> which are end view a part, such as a base material.
[0129] [Process -400] The same process as [process -100] - [a process -110] is performed first. [of the gestalt 1 of operation] In addition, in [a process -110] and the same process, patterning of a thin film 20 is unnecessary, or good in a line again based on a lithography technique and an etching technique. [patterning / which leaves a thin film 20 all over the cathode electrode 11 depending on the case] Or it may replace with [a process -100] and [a process -110], and the following processes may be performed again. That is, the mask layer which consists of a resist ingredient is formed on the base material 10 which consists of a glass substrate. It forms so that base materials 10 other than the part which should form a stripe-like cathode electrode for a mask layer may be covered. Subsequently, a conductor layer and a thin film are formed on the whole surface one by one in a spatter. Then, the laminated structure of the stripe-like cathode electrode 11 and a thin film 20 can be obtained by removing the thin film and conductor layer on it in a mask layer list. Such a process is also included by the process which forms a cathode electrode on a base material, and the process which forms the thin film which consists of a metal or metallic compounds on a cathode electrode.
[0130] Like [a process -410], next the [process -310] of the gestalt 3 of operation,

subsequently, an insulating layer 12 is formed in the whole surface, the gate electrode 13 which has 1st opening 14A is formed, further, 2nd opening 14B is formed in an insulating layer 12, and a thin film 20 is exposed at the pars basilaris ossis occipitalis of 2nd opening 14B (refer to (A) of drawing 9).
[0131] [Process -420] Subsequently, like the [process -120] of the gestalt 1 of operation, as shown in (B) of drawing 9 , a particle 21 is arranged on a thin film 20. Specifically, a particle 21 is arranged on the whole surface.
[0132] After that [[process -430]], anisotropic etching is performed to a thin film 20 like the [process -130] of the gestalt 1 of operation by using a particle 21 as the mask for etching, and it leaves alternatively the thin film 20 located under a particle 21 (refer to (A) of drawing 10). Subsequently, the electron emission section formation field 22 of the shape of an island which consists of the thin film 20 which removed the particle 21, with was left behind is formed.
[0133] [Process -440] Subsequently the electron emission section 15 which consists of the graphite which has crystallinity is alternatively formed on the electron emission section formation field 22 like the [process -140] of the gestalt 1 of operation based on a CVD method (refer to (B) of drawing 10).
[0134] After that [[process -450]], the [process -320] of the gestalt 3 of operation and the same process are performed, and, subsequently the assembly of a display is performed like the [process -150] of the gestalt 1 of operation.
[0135] (Gestalt 5 of operation) The gestalt 5 of operation is also deformation of the gestalt 3 of operation, and is related with the manufacture approach of the 2nd C. In addition, the field emission component in the gestalt 5 of operation also has the 1st structure.
[0136] Since the display of the gestalt 5 of operation has the same structure as the display of the gestalt 3 of operation, detailed explanation is omitted. Hereafter, the manufacture approach of the electron emission equipment of the gestalt 5 operation, the manufacture approach (the manufacture approach of the 2nd C) of a field emission component, and the manufacture approach of a display are explained with reference to typical drawing 11 and typical drawing 12 which are end view a part, such as a base material.
[0137] [Process -500] The same process as [process -100] - [a process -110] is performed first. [of the gestalt 1 of operation] In addition, in [a process -110] and the same process, patterning of a thin film 20 is unnecessary, or good in a line again based on a lithography technique and an etching technique. [patterning / which leaves a thin film 20 all over the cathode electrode 11 depending on the case] Or it may replace with [a process -100] and [a process -110], and the following processes may be performed again. That is, the mask layer which consists of a resist ingredient is formed on the base material 10 which consists of a glass substrate. It forms so that base materials 10 other than the part which should form a stripe-like cathode electrode for a mask layer may be covered. Subsequently, a conductor layer and a thin film are formed on the whole surface one by one in a spatter. Then, the laminated structure of the stripe-like cathode electrode 11 and a thin film 20 can be obtained by removing the thin film and conductor layer on it in a mask layer list. Such a process is also included by the process which forms a cathode electrode on a base material, and the process which forms the thin film which consists of a metal or metallic compounds on a cathode electrode.
[0138] [Process -510] Subsequently a particle 21 is arranged on a thin film 20 like the

[process -120] of the gestalt 1 of operation. Specifically, a particle 21 is arranged on the whole surface. Then, the electron emission section formation field 22 of the shape of an island which consists of the thin film 20 which performed anisotropic etching to the thin film 20 like the [process -130] of the gestalt 1 of operation by using a particle 21 as the mask for etching, removed the particle 21 after leaving alternatively the thin film 20 located under a particle 21, with was left behind is formed (refer to (A) of drawing 11).
[0139] An insulating layer 12 is formed in the whole surface like [a process -520], next the [process -310] of the gestalt 3 of operation (refer to (B) of drawing 11). Subsequently The gate electrode 13 which has 1st opening 14A is formed, further, 2nd opening 14B is formed in an insulating layer 12, and the cathode electrode 11 and the electron emission section formation field 22 are exposed at the pars basilaris ossis occipitalis of 2nd opening 14B (refer to (A) of drawing 12).
[0140] [Process -530] Subsequently the electron emission section 15 which consists of the graphite which has crystallinity is alternatively formed on the electron emission section formation field 22 like the [process -140] of the gestalt 1 of operation based on a CVD method (refer to (B) of drawing 12).
[0141] After that [[process -540]], the [process -320] of the gestalt 3 of operation and the same process are performed, and, subsequently the assembly of a display is performed like the [process -150] of the gestalt 1 of operation.
[0142] (Gestalt 6 of operation) The gestalt 6 of operation is also deformation of the gestalt 3 of operation, and is related with the manufacture approach of the 2nd D. In addition, the field emission component in the gestalt 6 of operation also has the 1st structure.
[0143] Since the display of the gestalt 6 of operation has the same structure as the display of the gestalt 3 of operation, detailed explanation is omitted. Hereafter, the manufacture approach of the electron emission equipment of the gestalt 6 operation, the manufacture approach (the manufacture approach of the 2nd D) of a field emission component, and the manufacture approach of a display are explained with reference to typical drawing 13 which is end view a part, such as a base material, - drawing 15 .
[0144] [Process -600] The cathode electrode 11 is first formed in base material top 10 like the [process -100] of the gestalt 1 of operation.
[0145] [Process -610] Subsequently, like the [process -310] of the gestalt 3 of operation, after forming an insulating layer 12 in the whole surface, the gate electrode 13 which has 1st opening 14A is formed, further, 2nd opening 14B is formed in an insulating layer 12, and the cathode electrode 11 is exposed at the pars basilaris ossis occipitalis of 2nd opening 14B (refer to (A) of drawing 13).
[0146] A thin film 20 is formed like the [process -110] of the gestalt 1 of operation after that [[process -620]] on the cathode electrode 11 exposed to the pars basilaris ossis occipitalis of 2nd opening 14B. Therefore, the mask layer 16 which consists of the mask ingredient which the front face of the cathode electrode 11 exposed is first formed in the center section of the pars basilaris ossis occipitalis of 2nd opening 14B (refer to (B) of drawing 13). After specifically forming a mask layer with a spin coat method all over including the inside of opening 14A and 14B, the mask layer 16 can be obtained by forming a pore in the mask layer located in the center section of the pars basilaris ossis occipitalis of 2nd opening 14B based on a lithography technique. In the gestalt 6 of operation, the mask layer 16 has covered some cathode electrodes 11 located in the pars

basilaris ossis occipitalis of 2nd opening 14B, the side attachment wall of 2nd opening 14B, the side attachment wall of 1st opening 14A, the gate electrode 13, and the insulating layer 12. Although a thin film 20 is formed in the front face of the part of the cathode electrode 11 located in the center section of the pars basilaris ossis occipitalis of 2nd opening 14B at subsequent processes by this, it can prevent certainly that the cathode electrode 11 and the gate electrode 13 short-circuit by formation of a thin film 20. And after forming a thin film 20 like the [process -110] of the gestalt 1 of operation, the mask layer 16 is removed (refer to (A) of drawing 14).
[0147] A particle 21 is arranged on the exposed thin film 20 like [a process -630], next the [process -120] of the gestalt 1 of operation. Specifically, a particle 21 is arranged on the whole surface. Then, the electron emission section formation field 22 of the shape of an island which consists of the thin film 20 which performed anisotropic etching to the thin film 20 like the [process -130] of the gestalt 1 of operation by using a particle 21 as the mask for etching, removed the particle 21 after leaving alternatively the thin film 20 located under a particle 21, with was left behind is formed (refer to (B) of drawing 14).
[0148] [Process -640] Subsequently the electron emission section 15 which consists of the graphite which has crystallinity is alternatively formed on the electron emission section formation field 22 like the [process -140] of the gestalt 1 of operation based on a CVD method (refer to drawing 15).
[0149] After that [[process -650]], the [process -320] of the gestalt 3 of operation and the same process are performed, and, subsequently the assembly of a display is performed like the [process -150] of the gestalt 1 of operation.
[0150] (Gestalt 7 of operation) The gestalt 7 of operation is also deformation of the gestalt 3 of operation. The field emission component in the gestalt 7 of operation has the 2nd structure. That is, the field-emission component of the gestalt 7 of operation consists of the electron-emission section 15 formed on the electron-emission section formation field 22 of the shape of an island formed on the band-like gate electrode supporter 112 which consists of the insulating material arranged on the base material 10, the cathode electrode 11 formed on the base material 10, the gate electrode 113 which consists of band-like ingredient 113A in which two or more openings 114 were formed, and the cathode electrode 11, and the electron-emission section formation field 22. The electron emission section 15 consists of graphite (carbon nanotube which specifically consisted of graphite which has sp2 association) which has the crystallinity formed on the electron emission section formation field 22. And band-like ingredient 113A is laid so that the top face of the gate electrode supporter 112 may be touched, and so that opening 114 may be located above the electron emission section 15. Electron emission equipment consists of the electron emission section formed on the electron emission section formation field 22 of the formed shape of an island formed on the conductor layer (it also sets in the gestalt 7 of operation and is specifically the cathode electrode 11), and the electron emission section formation field 22.
[0151] Band-like ingredient 113A is being fixed to the top face of the gate electrode supporter 112 with thermosetting adhesive (for example, epoxy system adhesives). a part of typical field emission component of the gestalt 7 of operation -- a sectional view is shown in (A) of drawing 16 , and the typical plot plan of the gate electrode supporter 112 is shown in the cathode electrode 11, band-like ingredient 113A and the gate electrode 113, and a list at (B) of drawing 1616 .

[0152] Hereafter, an example of the manufacture approach (the manufacture approach of the 2nd E) of the field emission component of the gestalt 7 of operation is explained.
[0153] [Process -700] The band-like gate electrode supporter 112 is first formed for example, based on the sandblasting method on a base material 10. Or the gate electrode supporter 112 may be formed again based on the combination of a CVD method and the etching method.
[0154] It is made to be the same as that of the [process -100] of the gestalt 1 of operation after that [[process -710]]. Form the cathode electrode 11 on a base material 10, and it is further made to be the same as that of the [process -110] of the gestalt 1 of operation. Form a thin film 20 on the cathode electrode 11, and it is made to be the same as that of the [process -120] of the gestalt 1 of operation. Arrange a particle 21 on a thin film 20, and it is made to be the same as that of the [process -130] of the gestalt 1 of operation. Anisotropic etching is performed to a thin film 20 by using a particle 21 as the mask for etching, and it leaves alternatively the thin film 20 located under a particle 21. Subsequently Form the electron emission section formation field 22 of the shape of an island which consists of the thin film 20 which removed the particle 21, with was left behind, and it is further made to be the same as that of the [process -140] of the gestalt 1 of operation. Based on a CVD method, the electron emission section 15 which consists of the graphite which has crystallinity is alternatively formed on the electron emission section formation field 22.
[0155] [Process -720] Stripe-like band-like ingredient 113A in which two or more openings 114 were formed is arranged in the condition of having been supported by the gate electrode supporter 112 so that two or more openings 114 might be located above the electron emission section 15, after that, with it consists of stripe-like band-like ingredient 113A, and the gate electrode 113 which has two or more openings 114 is located above the electron emission section 15. Stripe-like band-like ingredient 113A is fixable to the top face of the gate electrode supporter 112 with thermosetting adhesive (for example, epoxy system adhesives). In addition, the projection image of the stripe-like cathode electrode 11 and the projection image of stripe-like band-like ingredient 113A intersect perpendicularly.
[0156] In addition, it can also consider as the typical structure near the edge of a base material 10 where the both ends of stripe-like band-like ingredient 113A are being fixed to the periphery of a base material 10 so that a sectional view may be shown in part at drawing 17 . The height 117 is beforehand formed in the periphery of a base material 10, and the thin layer 118 of the same ingredient as the ingredient which constitutes band-like ingredient 113A in the top face of this height 117 is more specifically formed. And where stripe-like band-like ingredient 113A is laid, laser is used and welded to this thin layer 118. In addition, a height 117 can be formed in formation and coincidence of for example, a gate electrode supporter.
[0157] The flat-surface configuration of the opening 114 in the field emission component of the gestalt 7 of operation is not limited circularly. The modification of the configuration of opening 114 prepared in band-like ingredient 113A is illustrated to (A) of drawing 18 R> 8, (B), (C), and (D).
[0158] Moreover, in the gestalt 7 of operation, after performing [a process -710], [a process -700] may be performed.
[0159] As mentioned above, although this invention was explained based on the gestalt of

implementation of invention, this invention is not limited to these. In the gestalt of implementation of invention, although the electron emission section was constituted from a carbon nanotube, it is also possible to form the electron emission section which can constitute the electron emission section from a carbon nano fiber depending on the CVD conditions for forming the electron emission section, or has a conic configuration again.
[0160] In a field emission component, although the one electron emission section explained the gestalt corresponding to one opening chiefly, if it depends on the structure of a field emission component, it can also consider as the gestalt to which two or more electron emission sections corresponded to one opening, or the gestalt corresponding to two or more openings in the one electron emission section. Or it can also consider as the gestalt which prepares two or more 1st openings in a gate electrode, prepares the 2nd one opening which was open for free passage to two or more 1st openings concerning an insulating layer, and prepares 1 or two or more electron emission sections again.
[0161] In the gestalt of implementation of invention, although the thin film was formed in the spatter, it can also form with a CVD method or electrolysis plating. For example, the conditions for forming the thin film which consists of nickel (nickel) based on electrolysis plating are illustrated to the following table 4. In addition, a nickel plate is used as an anode plate. Moreover, what is necessary is just to perform electrolytic plating of the conditions illustrated to the following table 5, in order to form the thin film which consists of iron (Fe). In addition, a griddle is used as an anode plate. Furthermore, what is necessary is just to perform electroplating of the conditions illustrated to the following table 6, in order to form the thin film which consists of cobalt (Co). In addition, a cobalt plate is used as an anode plate.
[0162]
[Table 4]
Plating bath presentation: Ammonium chloride 1 % of the weight Boric acid 2 % of the weight Nickel sulfate 4 % of the weight Sodium dodecyl sulfate Whenever [0.1 % of the weight plating bath temperature]: 50-degreeC force current : An anode plate / gate inter-electrode 25 mA/dm2 : A gate electrode / cathode inter-electrode 0.5 mA/dm2 [0163]
[Table 5]
Plating bath presentation: Ammonium chloride 1 % of the weight Boric acid 2 % of the weight Iron sulfate 4 % of the weight Sodium dodecyl sulfate Whenever [0.1 % of the weight plating bath temperature]: 50-degreeC force current : An anode plate / gate inter-electrode 25 mA/dm2 : A gate electrode / cathode inter-electrode 0.5 mA/dm2 [0164]
[Table 6]
Plating bath presentation: Ammonium chloride 1 % of the weight Boric acid 2 % of the weight Cobalt sulfate 4 % of the weight Sodium dodecyl sulfate Whenever [0.1 % of the weight plating bath temperature]: 50-degreeC force current : An anode plate / gate inter-electrode 25 mA/dm2 : A gate electrode / cathode inter-electrode 0.5 mA/dm2 [0165] In the cold cathode field-electron-emission component of this invention, the 2nd insulating layer 62 may be further formed on the gate electrode 13 and an insulating layer 12, and the convergence electrode 63 may be formed on the 2nd insulating layer 62. a part of typical field emission component which has such structure -- end view is shown in drawing 19 . The 3rd opening 64 which was open for free passage to 1st opening 14A is formed in the 2nd insulating layer 62. If the gestalt 3 of operation has formation of the convergence electrode 63 In [a process -310], after forming the stripe-like gate electrode

13 on an insulating layer 12, the 2nd insulating layer 62 is formed. Subsequently What is necessary is to form the 3rd opening 64 in the convergence electrode 63 and the 2nd insulating layer 62, and just to prepare 1st opening 14A in the gate electrode 13 further, after forming the convergence electrode 63 by which patterning was carried out on the 2nd insulating layer 62. In addition, depending on patterning of a convergence electrode, it can also consider as the convergence electrode of a format with which 1, two or more electron emission sections, 1, or the convergence electrode units corresponding to two or more pixels gathered, or can also consider as the convergence electrode of the format which covered the service area with the electrical conducting material of the shape of a sheet of one sheet again.

[0166] In addition, after a convergence electrode forms the insulator layer which changes from SiO2 to both sides of the metal plate which consists of a nickel-Fe alloy 10 micrometers of 42% of thickness numbers, it not only forms it by such approach, but it can produce a convergence electrode by forming opening in the field corresponding to each pixel punching and by etching. And by accumulating a cathode panel, a metal plate, and an anode panel, and heat-treating by arranging a frame in the periphery section of both panels The insulator layer and insulating layer 12 which were formed in one field of a metal plate can be pasted up, the insulator layer and anode panel which were formed in the field of another side of a metal plate can be pasted up, these members can be made to be able to unify, and a display can also be completed by carrying out vacuum enclosure after that.

[0167] A gate electrode can also be used as the gate electrode of the format which covered the service area with the electrical conducting material (it has opening) of the shape of a sheet of one sheet. In this case, it considers as the same structure with the modification of the gestalt 1 of the operation which has a rectangle configuration having explained the cathode electrode. And a forward electrical potential difference (for example, 160 volts) is impressed to a gate electrode. Furthermore, the switching element which consists of TFT is prepared between the cathode electrodes and cathode electrode control circuits which constitute each pixel, the impression condition to the cathode electrode which constitutes each pixel is controlled by actuation of this switching element, and the luminescence condition of a pixel is controlled by it.

[0168] Or a cathode electrode can also be used as the cathode electrode of the format which covered the service area with the electrical conducting material of the shape of a sheet of one sheet again. In this case, it changes from a field emission component to the predetermined part of the electrical conducting material of the shape of a sheet of one sheet, and the electron emission field which constitutes each pixel is formed. And an electrical potential difference (for example, 0 volt) is impressed to a cathode electrode. Furthermore, the switching element which consists of TFT is prepared between the gate electrodes of a rectangle configuration and gate electrode control circuits which constitute each pixel, the condition of the electric field to the electron emission section which constitutes each pixel of being added is controlled by actuation of this switching element, and the luminescence condition of a pixel is controlled by it.

[0169]

[Effect of the Invention] As a result of being able to obtain a detailed electron emission section formation field by choosing the path of a particle as the electron emission equipment of this invention and its manufacture approach, a cold cathode field-electron-

emission component and its manufacture approach, and a list appropriately in a cold cathode field-electron-emission display and its manufacture approach, the electron emission section in which the point which is the part which emits an electron was radicalized can be obtained. So, the effectiveness of the electron emission from the electron emission section can improve, and reduction of threshold potential deltaVth can be aimed at, the image display which suppressed a flicker was stabilized and the cold cathode field-electron-emission display of a low power can be offered. And since the electron emission section consists of graphite which has crystallinity, low threshold potential deltaVth can be attained.

[0170] Moreover, since the electron emission section which has a path in general equal to the path of a particle can be formed, the electron emission section which has a desired path easily can be formed by changing a particle. Furthermore, if a particle is distributed in a solvent, by changing the amount of the particle in a solvent, it can control easily in the consistency of a request of the consistency of an electron emission section formation field, as a result the consistency of the electron emission section, and the consistency in the electron emission field of the electron emission section can be optimized easily. In addition, neither an X-ray-lithography technique nor an electron-beam-lithography technique needs to use a semi-conductor manufacture process, and the cold cathode field-electron-emission display possessing the field emission component which has the detailed electron emission section or this electron emission section with equipment simple and cheap moreover can be formed cheaply.

[0171] Moreover, according to the etching approach of the thin film of this invention, the detailed field below the limitation of the present photolithography technique can be formed in a thin film by choosing the path of a particle appropriately. Furthermore, if a particle is distributed in a solvent, it is easily controllable in the consistency of a request of the consistency of the thin film etched and left behind by changing the amount of the particle in a solvent.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] the cold cathode field-electron-emission display of the gestalt 1 of implementation of invention is typical -- it is a sectional view a part.

[Drawing 2] typical [base material / for explaining the manufacture approach of the cold cathode field-electron-emission component in the gestalt 1 of implementation of invention] -- it is a sectional view a part.

[Drawing 3] typical [substrate / for explaining the manufacture approach of the anode panel in the cold cathode field-electron-emission display of the gestalt 1 of implementation of invention] -- it is a sectional view a part.

[Drawing 4] It is the typical perspective view of the one electron emission section in the modification of the cold cathode field-electron-emission display of the gestalt 1 of implementation of invention.

[Drawing 5] the cold cathode field-electron-emission display of the gestalt 3 of implementation of invention is typical -- it is end view a part.

[Drawing 6] It is a typical partial perspective view when disassembling the cathode panel and anode panel in a cold cathode field-electron-emission display of a gestalt 3 of

implementation of invention.
[Drawing 7] typical [base material / for explaining the manufacture approach of the cold cathode field-electron-emission component in the gestalt 3 of implementation of invention] -- it is end view a part.
[Drawing 8] typical [base material / for explaining the manufacture approach of the cold cathode field-electron-emission component in the gestalt 3 of implementation of invention following on drawing 7] -- it is end view a part.
[Drawing 9] typical [base material / for explaining the manufacture approach of the cold cathode field-electron-emission component in the gestalt 4 of implementation of invention] -- it is end view a part.
[Drawing 10] typical [base material / for explaining the manufacture approach of the cold cathode field-electron-emission component in the gestalt 4 of implementation of invention following on drawing 9] -- it is end view a part.
[Drawing 11] typical [base material / for explaining the manufacture approach of the cold cathode field-electron-emission component in the gestalt 5 of implementation of invention] -- it is end view a part.
[Drawing 12] typical [base material / for explaining the manufacture approach of the cold cathode field-electron-emission component in the gestalt 5 of implementation of invention following on drawing 11] -- it is end view a part.
[Drawing 13] typical [base material / for explaining the manufacture approach of the cold cathode field-electron-emission component in the gestalt 6 of implementation of invention] -- it is end view a part.
[Drawing 14] typical [base material / for explaining the manufacture approach of the cold cathode field-electron-emission component in the gestalt 6 of implementation of invention following on drawing 13] -- it is end view a part.
[Drawing 15] typical [base material / for explaining the manufacture approach of the cold cathode field-electron-emission component in the gestalt 6 of implementation of invention following on drawing 14] -- it is end view a part.
[Drawing 16] the cold cathode field-electron-emission component in the gestalt 7 of implementation of invention is typical -- they are typical plot plans, such as a sectional view and a gate electrode, a part.
[Drawing 17] the cold cathode field-electron-emission component in the modification of the gestalt 7 of implementation of invention is typical -- it is a sectional view a part.
[Drawing 18] It is the typical top view showing two or more openings which the gate electrode in the gestalt 7 of implementation of invention has.
[Drawing 19] the cold cathode field-electron-emission component which is deformation of the cold cathode field-electron-emission component of the gestalt 3 of implementation of invention, and was equipped with the convergence electrode is typical -- it is end view a part.
[Drawing 20] It is the mimetic diagram showing the example of a configuration of the conventional cold cathode field-electron-emission display equipped with the Spindt mold cold cathode field-electron-emission component.
[Drawing 21] typical [base material / for explaining the manufacture approach of the conventional Spindt mold cold cathode field-electron-emission component] -- it is end view a part.
[Drawing 22] typical [base material / for continuing at drawing 21 and explaining the

manufacture approach of the conventional Spindt mold cold cathode field-electron-emission component] -- it is end view a part.

[Description of Notations]

CP ... A cathode panel, AP ... An anode panel, 10 ... Base material, 11 ... A cathode electrode, 12 ... An insulating layer, 112 ... Gate electrode supporter, 13,113 ... A gate electrode, 14, 14A, 14B, 114 ... Opening, 15 [... Particle,] ... The electron emission section, 16 ... A mask layer, 20 ... A thin film, 21 22 ... An electron emission section formation field, 30 ... A substrate, 31, 31R, 31G, 31B ... Fluorescent substance layer, 32 [... A cathode electrode control circuit, 41 / ... A gate electrode control circuit, 42 / ... Anode electrode control circuit] ... A black matrix, 33 ... An anode electrode, 34 ... A frame, 40

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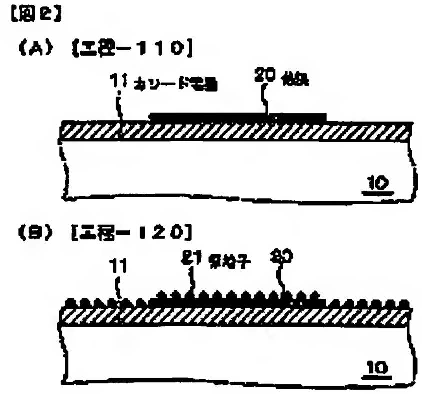
(54)【発明の名称】電子放出装置及びその製造方法、冷陰極電界電子放出素子及びその製造方法、冷陰極電界電子放出表示装置及びその製造方法、並びに、薄膜のエッチング方法

(57)【要約】
【課題】炭素系材料から構成された電子放出部の電子を放出する部分の先鋭化を達成し得る冷陰極電界電子放出素子の製造方法を提供する。
【解決手段】冷陰極電界電子放出素子の製造方法は、支持体10上に形成されたカソード電極11上に金属若しくは金属化合物から成る薄膜20を形成する工程と、薄膜20上に微粒子21を配置した後、該微粒子21をエッチング用マスクとして薄膜20に対して異方性のエッチングを行い、残された薄膜20から成る島状の電子放

【図2】


【特許請求の範囲】

【請求項１】（Ａ）導電体層上に、金属若しくは金属化合物から成る薄膜を形成する工程と、

（Ｂ）薄膜上に微粒子を配置する工程と、

（Ｃ）該微粒子をエッチング用マスクとして薄膜に対して異方性エッチングを行い、微粒子の下に位置する薄膜を選択的に残し、次いで、微粒子を除去し、以て、残された薄膜から成る島状の電子放出部形成領域を形成する工程と、

（Ｄ）化学的気相成長法に基づき、選択的に電子放出部形成領域上に結晶性を有するグラファイトから成る電子放出部を形成する工程、を具備することを特徴とする電子放出装置の製造方法。

【請求項２】微粒子の平均直径は1×10^{-9}m乃至1×10^{-7}mであり、薄膜の平均厚さは1×10^{-9}m乃至5×10^{-7}mであり、薄膜の法線方向における薄膜のエッチング速度をER_1、薄膜の法線方向における微粒子のエッチング速度をER_2としたとき、$ER_2 \leq 0.1ER_1$を満足することを特徴とする請求項１に記載の電子放出装置の製造方法。

【請求項３】薄膜上への微粒子の配置を、微粒子を分散させた溶媒を薄膜上に塗布した後、溶媒を除去する方法にて行うことを特徴とする請求項１に記載の電子放出装置の製造方法。

【請求項４】薄膜を、化学的気相成長法、物理的気相成長法、又は、メッキ法にて形成することを特徴とする請求項１に記載の電子放出装置の製造方法。

【請求項５】微粒子は、シリカ又はアルミナから成ることを特徴とする請求項１に記載の電子放出装置の製造方法。

【請求項６】（ａ）導電体層上に形成された金属若しくは金属化合物から成る島状の電子放出部形成領域、及び、

（ｂ）該電子放出部形成領域上に形成された結晶性を有するグラファイトから成る電子放出部、を備えていることを特徴とする電子放出装置。

【請求項７】電子放出部形成領域の平均直径は1×10^{-9}m乃至1×10^{-7}mであり、電子放出部形成領域の平均厚さは1×10^{-9}m乃至5×10^{-7}mであることを特徴とする請求項６に記載の電子放出装置。

（Ａ）支持体上にカソード電極を形成する工程と、

（Ｂ）カソード電極上に、金属若しくは金属化合物から成る薄膜を形成する工程と、

（Ｃ）薄膜上に微粒子を配置する工程と、

（Ｄ）該微粒子をエッチング用マスクとして薄膜に対して異方性エッチングを行い、微粒子の下に位置する薄膜を選択的に残し、次いで、微粒子を除去し、以て、残された薄膜から成る島状の電子放出部形成領域を形成する工程と、

（Ｅ）化学的気相成長法に基づき、選択的に電子放出部形成領域上に結晶性を有するグラファイトから成る電子放出部を形成する工程、を具備することを特徴とする冷陰極電界電子放出素子の製造方法。

【請求項１０】（ａ）支持体上に設けられたカソード電極、

（ｂ）カソード電極上に形成された島状の電子放出部形成領域、

（ｃ）電子放出部形成領域上に形成された電子放出部、及び、

（ｄ）電子放出部の上方に配設され、開口部を有するゲート電極、を具備する冷陰極電界電子放出素子の製造方法であって、

（Ａ）支持体上にカソード電極を形成する工程と、

（Ｂ）カソード電極上に、金属若しくは金属化合物から成る薄膜を形成する工程と、

（Ｃ）薄膜上に微粒子を配置する工程と、

（Ｄ）該微粒子をエッチング用マスクとして薄膜に対して異方性エッチングを行い、微粒子の下に位置する薄膜を選択的に残し、次いで、微粒子を除去し、以て、残された薄膜から成る島状の電子放出部形成領域を形成する工程と、

（Ｅ）化学的気相成長法に基づき、選択的に電子放出部形成領域上に結晶性を有するグラファイトから成る電子放出部を形成する工程、を具備することを特徴とする冷陰極電界電子放出素子の製造方法。

【請求項１１】前記工程（Ｅ）の後、全面に絶縁層を形成し、次いで、開口部を有するゲート電極を形成し、更に、絶縁層に第２の開口部を形成して、第２の開口部の底部に電子放出部を露出させる工程を更に具備することを特徴とする請求項１０に記載の冷陰極電界電子放出素

底部にカソード電極及び電子放出部形成領域を露出させる工程を更に具備することを特徴とする請求項10に記載の冷陰極電界電子放出素子の製造方法。

【請求項14】前記工程（A）の後、全面に絶縁層を形成し、次いで、開口部を有するゲート電極を形成し、更に、絶縁層に第2の開口部を形成して、第2の開口部の底部にカソード電極を露出させる工程を更に具備することを特徴とする請求項10に記載の冷陰極電界電子放出素子の製造方法。

【請求項15】微粒子の平均直径は1×10^{-9}m乃至1×10^{-7}mであり、薄膜の平均厚さは1×10^{-8}m乃至5×10^{-7}mであり、薄膜の法線方向における薄膜のエッチング速度をER_1、薄膜の法線方向における微粒子のエッチング速度をER_2としたとき、$ER_2\leq0.1ER_1$を満足することを特徴とする請求項9乃至請求項14のいずれか1項に記載の冷陰極電界電子放出素子の製造方法。

【請求項16】薄膜上への微粒子の配置を、微粒子を分散させた溶媒を薄膜上に塗布した後、溶媒を除去する方法にて行うことを特徴とする請求項9乃至請求項14のいずれか1項に記載の冷陰極電界電子放出素子の製造方法。

【請求項17】薄膜を、化学的気相成長法、物理的気相成長法、又は、メッキ法にて形成することを特徴とする請求項9乃至請求項14のいずれか1項に記載の冷陰極電界電子放出素子の製造方法。

【請求項18】微粒子は、シリカ又はアルミナから成ることを特徴とする請求項9乃至請求項14のいずれか1項に記載の冷陰極電界電子放出素子の製造方法。

【請求項19】冷陰極電界電子放出素子が複数設けられたカソードパネル、及び、蛍光体層とアノード電極とを備えたアノードパネルが、それらの周縁部で接合されて成り、

冷陰極電界電子放出素子は、

（a）支持体上に設けられたカソード電極、

（b）カソード電極上に形成された島状の電子放出部形成領域、及び、

（c）電子放出部形成領域上に形成された電子放出部、

を具備する冷陰極電界電子放出表示装置の製造方法であって、

形成領域上に結晶性を有するグラファイトから成る電子放出部を形成する工程、を具備することを特徴とする冷陰極電界電子放出表示装置の製造方法。

【請求項20】冷陰極電界電子放出素子が複数設けられたカソードパネル、及び、蛍光体層とアノード電極とを備えたアノードパネルが、それらの周縁部で接合されて成り、

冷陰極電界電子放出素子は、

（a）支持体上に設けられたカソード電極、

（b）カソード電極上に形成された島状の電子放出部形成領域、

（c）電子放出部形成領域上に形成された電子放出部、及び、

（d）電子放出部の上方に配設され、開口部を有するゲート電極、を具備する冷陰極電界電子放出表示装置の製造方法であって、

（A）支持体上にカソード電極を形成する工程と、

（B）カソード電極上に、金属若しくは金属化合物から成る薄膜を形成する工程と、

（C）薄膜上に微粒子を配置する工程と、

（D）該微粒子をエッチング用マスクとして薄膜に対して異方性エッチングを行い、微粒子の下に位置する薄膜を選択的に残し、次いで、微粒子を除去し、以て、残された薄膜から成る島状の電子放出部形成領域を形成する工程と、

（E）化学的気相成長法に基づき、選択的に電子放出部形成領域上に結晶性を有するグラファイトから成る電子放出部を形成する工程、を具備することを特徴とする冷陰極電界電子放出表示装置の製造方法。

【請求項21】前記工程（E）の後、全面に絶縁層を形成し、次いで、開口部を有するゲート電極を形成し、更に、絶縁層に第2の開口部を形成して、第2の開口部の底部に電子放出部を露出させる工程を更に具備することを特徴とする請求項20に記載の冷陰極電界電子放出表示装置の製造方法。

【請求項22】前記工程（B）の後、全面に絶縁層を形成し、次いで、開口部を有するゲート電極を形成し、更に、絶縁層に第2の開口部を形成して、第2の開口部の底部に薄膜を露出させる工程を更に具備することを特徴とする請求項20に記載の冷陰極電界電子放出表示装置

底部にカソード電極を露出させる工程を更に具備することを特徴とする請求項２０に記載の冷陰極電界電子放出表示装置の製造方法。

【請求項２５】（ａ）支持体上に設けられたカソード電極、

（ｂ）カソード電極上に形成された島状の電子放出部形成領域、及び、

（ｃ）電子放出部形成領域上に形成された電子放出部、を具備する冷陰極電界電子放出素子であって、

該電子放出部形成領域は、金属若しくは金属化合物から成り、

該電子放出部は、該電子放出部形成領域上に形成された結晶性を有するグラファイトから成ることを特徴とする冷陰極電界電子放出素子。

【請求項２６】（ａ）支持体上に設けられたカソード電極、

（ｂ）カソード電極上に形成された島状の電子放出部形成領域、

（ｃ）電子放出部形成領域上に形成された電子放出部、及び、

（ｄ）電子放出部の上方に配設され、開口部を有するゲート電極、を具備する冷陰極電界電子放出素子であって、

該電子放出部形成領域は、金属若しくは金属化合物から成り、

該電子放出部は、該電子放出部形成領域上に形成された結晶性を有するグラファイトから成ることを特徴とする冷陰極電界電子放出素子。

【請求項２７】電子放出部形成領域の平均直径は1×10^{-9}m乃至1×10^{-7}mであり、電子放出部形成領域の平均厚さは1×10^{-9}m乃至5×10^{-7}mであることを特徴とする請求項２５又は請求項２６に記載の冷陰極電界電子放出素子。

【請求項２８】電子放出部の先端部の曲率半径は1×10^{-9}m乃至1×10^{-7}mであることを特徴とする請求項２７に記載の冷陰極電界電子放出素子。

【請求項２９】冷陰極電界電子放出素子が複数設けられたカソードパネル、及び、蛍光体層とアノード電極とを備えたアノードパネルが、それらの周縁部で接合されて成る冷陰極電界電子放出表示装置であって、

冷陰極電界電子放出表示装置。

【請求項３０】冷陰極電界電子放出素子が複数設けられたカソードパネル、及び、蛍光体層とアノード電極とを備えたアノードパネルが、それらの周縁部で接合されて成る冷陰極電界電子放出表示装置であって、

冷陰極電界電子放出素子は、

（ａ）支持体上に設けられたカソード電極、

（ｂ）カソード電極上に形成された島状の電子放出部形成領域、

（ｃ）電子放出部形成領域上に形成された電子放出部、及び、

（ｄ）電子放出部の上方に配設され、開口部を有するゲート電極、を具備し、

該電子放出部形成領域は、金属若しくは金属化合物から成り、

該電子放出部は、該電子放出部形成領域上に形成された結晶性を有するグラファイトから成ることを特徴とする冷陰極電界電子放出表示装置。

【請求項３１】電子放出部形成領域の平均直径は1×10^{-9}m乃至1×10^{-7}mであり、電子放出部形成領域の平均厚さは1×10^{-9}m乃至5×10^{-7}mであることを特徴とする請求項２９又は請求項３０に記載の冷陰極電界電子放出表示装置。

【請求項３２】電子放出部の先端部の曲率半径は1×10^{-9}m乃至1×10^{-7}mであることを特徴とする請求項３１に記載の冷陰極電界電子放出表示装置。

【請求項３３】薄膜上に微粒子を配置した後、該微粒子をエッチング用マスクとして薄膜に対して異方性エッチングを行い、微粒子の下に位置する薄膜を選択的に残し、次いで、微粒子を除去することを特徴とする薄膜のエッチング方法。

【請求項３４】微粒子の平均直径は1×10^{-9}m乃至1×10^{-7}mであり、薄膜の平均厚さは1×10^{-9}m乃至5×10^{-7}mであり、薄膜の法線方向における薄膜のエッチング速度をER_1、薄膜の法線方向における微粒子のエッチング速度をER_2としたとき、$ER_2 \leq 0.1 ER_1$を満足することを特徴とする請求項３３に記載の薄膜のエッチング方法。

【請求項３５】薄膜上への微粒子の配置を、微粒子を分散させた溶媒を薄膜上に塗布した後、溶媒を除去する方

【発明の属する技術分野】本発明は、電子放出装置及びその製造方法、冷陰極電界電子放出素子及びその製造方法、冷陰極電界電子放出表示装置及びその製造方法、並びに、薄膜のエッチング方法に関する。

【0002】

【従来の技術】真空中に置かれた金属や半導体等に或る閾値以上の強さの電界を与えると、金属や半導体の表面近傍のエネルギー障壁を電子が量子トンネル効果によって通過し、常温でも真空中に電子が放出されるようになる。かかる原理に基づく電子放出は、冷陰極電界電子放出、あるいは単に電界放出（フィールド・エミッション）と呼ばれる。近年、この電界放出の原理を画像表示に応用した平面型の冷陰極電界電子放出表示装置、所謂フィールド・エミッション・ディスプレイ（ＦＥＤ）が提案されており、高輝度、低消費電力等の長所を有することから、従来の陰極線管（ＣＲＴ）に代わる画像表示装置として期待されている。

【０００３】冷陰極電界電子放出表示装置（以下、単に、表示装置と呼ぶ場合がある）は、一般に、２次元マトリクス上に配列された画素に対応して電子放出部を有するカソードパネルと、電子放出部から放出された電子との衝突により励起され発光するアノードパネルとが、真空空間を挟んで対向配置された構造を有する。カソードパネル上の各画素においては、通常、複数の電子放出部が形成され、更に、電子放出部から電子を引き出すためのゲート電極も形成されている。電子の放出に関する最小構造単位、即ち、電子放出部とゲート電極を有する部分が冷陰極電界電子放出素子である。以下、冷陰極電界電子放出素子を、単に電界放出素子と呼ぶ場合がある。

【０００４】図２０に、かかる表示装置の構成例を示す。図示した電界放出素子は、円錐形の電子放出部を有する、所謂スピント（Ｓｐｉｎｄｔ）型電界放出素子と呼ばれるタイプの電界放出素子である。この電界放出素子は、支持体２１０上に形成されたカソード電極２１１と、支持体２１０及びカソード電極２１１上に形成された絶縁層２１２と、絶縁層２１２上に形成されたゲート電極２１３と、ゲート電極２１３及び絶縁層２１２に設けられた開口部２１４と、開口部２１４の底部に位置するカソード電極２１１上に形成された円錐形の電子放出

【０００５】一方、アノードパネルＡＰは、基板３０と、基板３０上に所定のパターン（例えば、ドット状あるいはストライプ状）に従って形成された蛍光体層３１と、蛍光体層３１上に形成されたアノード電極３３から構成されている。尚、蛍光体層３１と蛍光体層３１との間の基板３０上にはブラックマトリックス３２が形成されている。１画素は、カソードパネル側のカソード電極２１１とゲート電極２１３との重複領域に所定数配列された電界放出素子の一群と、これらの電界放出素子の一群に対面したアノードパネル側の蛍光体層３１とによって構成されている。有効領域には、かかる画素が、例えば数十万～数百万個ものオーダーにて配列されている。

【０００６】アノードパネルＡＰとカソードパネルＣＰとを、電界放出素子と蛍光体層３１とが対向するように配置し、周縁部において枠体３４を介して接合することによって、表示装置を作製することができる。カソードパネルＣＰとアノードパネルＡＰとは、０．１ｍｍ～１ｍｍ程度の距離を隔てて対向配置させている。有効領域を包囲し、画素を選択するための周辺回路が形成された無効領域（例えば、カソードパネルＣＰの無効領域）には、真空排気用の貫通孔（図示せず）が設けられており、この貫通孔には真空排気後に封じ切られたチップ管（図示せず）が接続されている。即ち、アノードパネルＡＰとカソードパネルＣＰと枠体３４とによって囲まれた空間は真空となっている。

【０００７】電界放出素子においては、ゲート電極２１３に印加される電圧とカソード電極２１１に印加される電圧の電位差ΔＶが或る閾値電位ΔV_{th}以上になると、電子放出部２１５の先端部から電子が放出され始める。そして、例えばゲート電極２１３に印加される電圧の増加（即ち、電位差ΔＶの増加）に伴い、電子放出部２１５の先端部からの電子の放出によって生成する放出電子電流が急激に増加する。

【０００８】カソード電極２１１には相対的な負電圧がカソード電極制御回路４０から印加され、ゲート電極２１３には相対的な正電圧がゲート電極制御回路４１から印加され、アノード電極３３にはゲート電極２１３よりも更に高い正電圧がアノード電極制御回路４２から印加される。かかる表示装置において表示を行う場合、例えば、カソード電極２１１にカソード電極制御回路４０か

圧によって制御される。

【0009】以下、従来のスピント型電界放出素子の製造方法の概要を説明するが、この製造方法は、基本的には、円錐形の電子放出部215を金属材料の垂直蒸着により形成する方法である。即ち、開口部214に対して蒸着粒子は垂直に入射するが、開口部214の付近に形成されるオーバーハング状の堆積物による遮蔽効果を利用して、開口部214の底部に到達する蒸着粒子の量を漸減させ、円錐形の堆積物である電子放出部215を自己整合的に形成する。以下、不要なオーバーハング状の堆積物の除去を容易とするために、ゲート電極213上に剥離層217を予め形成しておく方法に基づくスピント型電界放出素子の製造方法の概要を、支持体等の模式的な一部端面図である図21及び図22を参照して説明する。

【0010】［工程－10］先ず、例えばガラスから成る支持体210上にニオブ（Nb）から成るストライプ状のカソード電極211を形成した後、全面にSiO_2から成る絶縁層212を形成し、更に、ストライプ状のゲート電極213を絶縁層212上に形成する。ゲート電極213の形成は、例えば、スパッタ法、リソグラフィ技術及びドライエッチング技術に基づき行うことができる。

【0011】［工程－20］次に、ゲート電極213及び絶縁層212に、エッチング用マスクとして機能するレジスト層216をリソグラフィ技術によって形成する（図21の（A）参照）。その後、RIE（反応性イオン・エッチング）法にてゲート電極213に第1の開口部214Aを形成し、更に、この第1の開口部214Aと連通した第2の開口部214Bを絶縁層212に形成する。尚、第1の開口部214A及び第2の開口部214Bを総称して、開口部214と呼ぶ。開口部214の底部にカソード電極211が露出している。その後、レジスト層216をアッシング技術によって除去する。こうして、図21の（B）に示す構造を得ることができる。

【0012】［工程－30］次に、開口部214の底部に露出したカソード電極211上に、電子放出部215を形成する。具体的には、全面にアルミニウムを斜め蒸着することにより、剥離層217を形成する。このとき、ゲート電極213の開口端部から大きく張り出した形状を有するモリブデンから成る導電材料層218が成長するに伴い、開口部214の実質的な直径が次第に縮小されるので、開口部214の底部において堆積に寄与する蒸着粒子は、次第に開口部214の中央付近を通過するものに限られるようになる。その結果、開口部214の底部には円錐形の堆積物が形成され、この円錐形のモリブデンから成る堆積物が電子放出部215となる。

【0014】［工程－50］その後、電気化学的プロセス及び湿式プロセスによって剥離層217を絶縁層212及びゲート電極213の表面から剥離し、絶縁層212及びゲート電極213の上方の導電材料層218を選択的に除去する。その結果、図22の（B）に示すように、開口部214の底部に位置するカソード電極211上に円錐形の電子放出部215を残すことができる。尚、このような電子放出部215の形成方法においては、本質的に、1つの開口部214内に1つの電子放出部215が形成される。

【0015】かかる表示装置の構成において、低い駆動電圧で大きな放出電子電流を得るためには、電子放出部の先端部を鋭く尖らせることが有効であり、この観点から、上述のスピント型電界放出素子の電子放出部215は優れた性能を有していると云える。しかしながら、電子放出部215の先端部は数十nm程度、例えば60nm程度であり、一層の高解像度を達成するために、電子放出部の先端部の一層の先鋭化が望まれている。

【0016】しかも、円錐形の電子放出部215の形成には高度な加工技術を要する。また、場合によっては数千万個以上にも及ぶ電子放出部215を有効領域の全域に亙って均一に形成することは、有効領域の面積が増大するにつれて困難となりつつある。即ち、大面積の支持体全体に亙って均一な膜質、膜厚を有する導電材料層218を垂直蒸着法により形成したり、均一な寸法の庇形状を有する剥離層217を斜め蒸着法により形成することは、極めて困難であり、何らかの面内バラツキやロット間バラツキは避けられない。このバラツキにより、表示装置の画像表示特性、例えば画像の明るさにバラツキが生じる。しかも、大面積に亙って形成された剥離層217を除去する際に、その残渣がカソードパネルCPを汚染する原因となり、表示装置の製造歩留を低下させるという問題も生じる。

ド、グラファイト、カーボンナノチューブ等、結合形態を変化させることが可能である。

【0018】例えば、第59回応用物理学会学術講演会講演予稿集p．480，演題番号15p－P－13（1998年）には、DLC（ダイヤモンドライクカーボン）薄膜が提案されている。

【0019】

【発明が解決しようとする課題】しかしながら、DLC薄膜の膜質や構造と電子放出特性との関係は未だ不明な点が多く、現在、研究課題となっている。特に、DLC薄膜の膜質を制御して、低閾値電位ΔV_{th}で高い電子放出効率を確保するためには、成膜反応を司る成膜条件等の設定が重要であるが、現在得られているDLC薄膜の閾値電位ΔV_{th}はいずれも高い値しか示さない。

【0020】このような問題に対して、材料固有の性質として、低閾値電位特性を有する炭素材料が、例えば、第60回応用物理学会学術講演会講演予稿集p．631、演題番号2p－H－6（1999年）に提案されている。この文献には、石英基板上に電子ビーム蒸着法によって形成したチタン薄膜表面をダイヤモンドパウダーによりスクラッチ加工を施した後、チタン薄膜をパターニングして中央部に数μmのギャップを設け、次いで、ノンドープダイヤモンド薄膜をチタン薄膜上に成膜する平面構造型電子エミッターが開示されている。あるいは又、第60回応用物理学会学術講演会講演予稿集p．632、演題番号2p－H－11（1999年）には、金属クロスラインを付けた石英ガラス上にカーボンナノチューブを形成する技術が開示されている。また、J. Vac. Sci. Technol. B 17(2), 674, MAr/Apr 1999 に開示されている、微細結晶グラファイトと呼ばれる微細構造を有する炭素系構造体も、同様の理由から注目を集めている。

【0021】ところで、カーボンナノチューブや微細結晶グラファイトと呼ばれる微細構造を有する炭素系構造体においても、閾値電界を一層低くするためには、電子を放出する部分を先鋭化することが重要である。

【0022】また、各種の薄膜から現在のフォトリソグラフィ技術の限界以下の微細な領域を形成するためには、一般に、X線リソグラフィ技術や電子線リソグラフィ技術を用いる必要がある。しかしながら、これらの技

とを可能とする薄膜のエッチング方法を提供することにある。

【0025】

【課題を解決するための手段】上記の第1の目的を達成するための本発明の電子放出装置の製造方法は、（A）導電体層上に、金属若しくは金属化合物から成る薄膜を形成する工程と、（B）薄膜上に微粒子を配置する工程と、（C）該微粒子をエッチング用マスクとして薄膜に対して異方性エッチングを行い、微粒子の下に位置する薄膜を選択的に残し、次いで、微粒子を除去し、以て、残された薄膜から成る島状の電子放出部形成領域を形成する工程と、（D）化学的気相成長法に基づき、選択的に電子放出部形成領域上に結晶性を有するグラファイトから成る電子放出部を形成する工程、を具備することを特徴とする。

【0026】尚、島状の電子放出部形成領域が導電体層上に形成されているとは、導電体層を海に見立てたとき、電子放出部形成領域が島状に点在していることを意味する。

【0027】上記の第1の目的を達成するための本発明の第1の態様に係る冷陰極電界電子放出素子の製造方法は、所謂2電極型の冷陰極電界電子放出表示装置を構成する冷陰極電界電子放出素子の製造方法である。即ち、本発明の第1の態様に係る冷陰極電界電子放出素子の製造方法は、（a）支持体上に設けられたカソード電極、（b）カソード電極上に形成された島状の電子放出部形成領域、及び、（c）電子放出部形成領域上に形成された電子放出部、を具備する冷陰極電界電子放出素子の製造方法であって、（A）支持体上にカソード電極を形成する工程と、（B）カソード電極上に、金属若しくは金属化合物から成る薄膜を形成する工程と、（C）薄膜上に微粒子を配置する工程と、（D）該微粒子をエッチング用マスクとして薄膜に対して異方性エッチングを行い、微粒子の下に位置する薄膜を選択的に残し、次いで、微粒子を除去し、以て、残された薄膜から成る島状の電子放出部形成領域を形成する工程と、（E）化学的気相成長法に基づき、選択的に電子放出部形成領域上に結晶性を有するグラファイトから成る電子放出部を形成する工程、を具備することを特徴とする。

【0028】尚、島状の電子放出部形成領域がカソード

成領域、（ｃ）電子放出部形成領域上に形成された電子放出部、及び、（ｄ）電子放出部の上方に配設され、開口部を有するゲート電極、を具備する冷陰極電界電子放出素子の製造方法であって、（Ａ）支持体上にカソード電極を形成する工程と、（Ｂ）カソード電極上に、金属若しくは金属化合物から成る薄膜を形成する工程と、（Ｃ）薄膜上に微粒子を配置する工程と、（Ｄ）該微粒子をエッチング用マスクとして薄膜に対して異方性エッチングを行い、微粒子の下に位置する薄膜を選択的に残し、次いで、微粒子を除去し、以て、残された薄膜から成る島状の電子放出部形成領域を形成する工程と、（Ｅ）化学的気相成長法に基づき、選択的に電子放出部形成領域上に結晶性を有するグラファイトから成る電子放出部を形成する工程、を具備することを特徴とする。

【００３０】上記の第１の目的を達成するための本発明の第１の態様に係る冷陰極電界電子放出表示装置の製造方法は、所謂２電極型の冷陰極電界電子放出表示装置の製造方法である。即ち、本発明の第１の態様に係る冷陰極電界電子放出表示装置の製造方法は、冷陰極電界電子放出素子が複数設けられたカソードパネル、及び、蛍光体層とアノード電極とを備えたアノードパネルが、それらの周縁部で接合されて成り、冷陰極電界電子放出素子は、（ａ）支持体上に設けられたカソード電極、（ｂ）カソード電極上に形成された島状の電子放出部形成領域、及び、（ｃ）電子放出部形成領域上に形成された電子放出部、を具備する冷陰極電界電子放出表示装置の製造方法であって、（Ａ）支持体上にカソード電極を形成する工程と、（Ｂ）カソード電極上に、金属若しくは金属化合物から成る薄膜を形成する工程と、（Ｃ）薄膜上に微粒子を配置する工程と、（Ｄ）該微粒子をエッチング用マスクとして薄膜に対して異方性エッチングを行い、微粒子の下に位置する薄膜を選択的に残し、次いで、微粒子を除去し、以て、残された薄膜から成る島状の電子放出部形成領域を形成する工程と、（Ｅ）化学的気相成長法に基づき、選択的に電子放出部形成領域上に結晶性を有するグラファイトから成る電子放出部を形成する工程、を具備することを特徴とする。

【００３１】上記の第１の目的を達成するための本発明の第２の態様に係る冷陰極電界電子放出表示装置の製造方法は、所謂３電極型の冷陰極電界電子放出表示装置の

示装置の製造方法であって、（Ａ）支持体上にカソード電極を形成する工程と、（Ｂ）カソード電極上に、金属若しくは金属化合物から成る薄膜を形成する工程と、（Ｃ）薄膜上に微粒子を配置する工程と、（Ｄ）該微粒子をエッチング用マスクとして薄膜に対して異方性エッチングを行い、微粒子の下に位置する薄膜を選択的に残し、次いで、微粒子を除去し、以て、残された薄膜から成る島状の電子放出部形成領域を形成する工程と、（Ｅ）化学的気相成長法に基づき、選択的に電子放出部形成領域上に結晶性を有するグラファイトから成る電子放出部を形成する工程、を具備することを特徴とする。

【００３２】本発明の第２の態様に係る冷陰極電界電子放出素子の製造方法若しくは本発明の第２の態様に係る冷陰極電界電子放出表示装置の製造方法にあっては、前記工程（Ｅ）の後、全面に絶縁層を形成し、次いで、開口部を有するゲート電極を形成し、更に、絶縁層に第２の開口部を形成して、第２の開口部の底部に電子放出部を露出させる工程を更に具備する構成とすることができる。尚、このような構成を、便宜上、本発明の第２Ａの製造方法と呼ぶ。

【００３３】あるいは又、本発明の第２の態様に係る冷陰極電界電子放出素子の製造方法若しくは本発明の第２の態様に係る冷陰極電界電子放出表示装置の製造方法にあっては、前記工程（Ｂ）の後、全面に絶縁層を形成し、次いで、開口部を有するゲート電極を形成し、更に、絶縁層に第２の開口部を形成して、第２の開口部の底部に薄膜を露出させる工程を更に具備する構成とすることができる。尚、このような構成を、便宜上、本発明の第２Ｂの製造方法と呼ぶ。

【００３４】あるいは又、本発明の第２の態様に係る冷陰極電界電子放出素子の製造方法若しくは本発明の第２の態様に係る冷陰極電界電子放出表示装置の製造方法にあっては、前記工程（Ｄ）の後、全面に絶縁層を形成し、次いで、開口部を有するゲート電極を形成し、更に、絶縁層に第２の開口部を形成して、第２の開口部の底部にカソード電極及び電子放出部形成領域を露出させる工程を更に具備する構成とすることができる。尚、このような構成を、便宜上、本発明の第２Ｃの製造方法と呼ぶ。

【００３５】あるいは又、本発明の第２の態様に係る冷

口部の底部の中央部にカソード電極の表面が露出したマスク層を形成した後（即ち、少なくとも第２の開口部の側壁にマスク層を形成した後）、露出したカソード電極の表面を含むマスク層上に、薄膜を形成する工程から成る構成とすることができる。かかるマスク層の形成は、例えば、レジスト材料層を全面に塗布した後、リソグラフィ技術に基づき、第２の開口部の底部の中央部に位置するレジスト材料層に孔部を形成する方法により行うことができる。第２の開口部の底部に位置するカソード電極の一部分、第２の開口部の側壁、第１の開口部の側壁及びゲート電極がマスク層で被覆された状態で、第２の開口部の底部の中央部に位置するカソード電極の表面に薄膜を形成するので、カソード電極とゲート電極とが、薄膜によって短絡することを確実に防止し得る。場合によっては、ゲート電極の上のみをマスク層で被覆してもよい。あるいは又、ゲート電極に設けられた第１の開口部の近傍のゲート電極の上のみをマスク層で被覆してもよいし、第１の開口部の近傍のゲート電極上及び第１の開口部と第２の開口部の側壁をマスク層で被覆してもよい。これらの場合、ゲート電極を構成する導電材料やＣＶＤ条件によっては、ゲート電極上に電子放出部が形成され得るが、かかる電子放出部が高強度の電界中に置かれなければ、かかる電子放出部から電子が放出されることはない。尚、工程（Ｅ）の実行前のいずれかの工程においてマスク層を除去することが好ましい。

【００３７】あるいは又、本発明の第２の態様に係る冷陰極電界電子放出素子の製造方法若しくは本発明の第２の態様に係る冷陰極電界電子放出表示装置の製造方法にあっては、冷陰極電界電子放出素子を形成する方法として、絶縁材料から成る帯状あるいは井桁状のゲート電極支持部を支持体上に形成し、次いで、前記工程（Ａ）～工程（Ｅ）を実行した後、複数の開口部が形成された帯状材料から成るゲート電極がゲート電極支持部の頂面に接するように、且つ、電子放出部の上方に開口部が位置するように、帯状材料を張架する工程から成る方法（以下、第２Ｅの製造方法と呼ぶ場合がある）を採用することもできる。

【００３８】第２Ｅの製造方法にあっては、ゲート電極支持部を、隣り合うストライプ状のカソード電極の間の領域、あるいは、複数のカソード電極を一群のカソードじた開口部にゲート電極支持部形成用の絶縁材料を埋め込み、焼成する方法である。感光性フィルムは焼成によって燃焼、除去され、開口部に埋め込まれたゲート電極支持部形成用の絶縁材料が残り、ゲート電極支持部となる。感光法とは、支持体上に感光性を有するゲート電極支持部形成用の絶縁材料を形成し、露光及び現像によってこの絶縁材料をパターニングした後、焼成を行う方法である。

【００３９】本発明の電子放出装置の製造方法、各種形態を含む第１の態様あるいは第２の態様に係る冷陰極電界電子放出素子の製造方法、各種形態を含む第１の態様あるいは第２の態様に係る冷陰極電界電子放出表示装置の製造方法（以下、これらを総称して、単に、本発明の製造方法と呼ぶ場合がある）にあっては、微粒子の平均直径は 1×10^{-9} m乃至 1×10^{-7} m、好ましくは 1×10^{-9} m乃至 1×10^{-8} mであり、薄膜の平均厚さは 1×10^{-9} m乃至 5×10^{-7} m、好ましくは 1×10^{-9} m乃至 1×10^{-7} mであり、薄膜の法線方向における薄膜のエッチング速度を ER_1、薄膜の法線方向における微粒子のエッチング速度を ER_2 としたとき、$ER_2 \leqq 0.1 ER_1$、好ましくは $ER_2 \leqq 0.01 ER_1$ を満足することが望ましい。微粒子及び薄膜を構成する材料を適宜選択し、且つ、エッチング条件を適切に設定することによって、$ER_2 \leqq 0.1 ER_1$ を満足させることができる。尚、得られた電子放出部の先端部の曲率半径を 1×10^{-9} m乃至 1×10^{-7} mとすることが望ましい。

【００４０】本発明の製造方法において、薄膜上への微粒子の配置を、微粒子を分散させた溶媒を薄膜上に塗布した後、溶媒を除去する方法にて行うことが、配置方法の容易性、簡便性、薄膜上へ微粒子を出来る限り均一に配置するといった観点から好ましい。また、薄膜を、化学的気相成長法（ＣＶＤ法）又は物理的気相成長法（ＰＶＤ法）にて形成し、あるいは又、メッキ法（電解メッキ法及び無電解メッキ法を含む）にて形成することが、均一な膜厚を有する均質な薄膜を容易に形成できるといった観点から好ましい。尚、微粒子は、コロイダルシリカを含むシリカ又はアルミナ、酸化銅、酸化銀、金から成ることが好ましい。また、エッチングを、イオン照射による物理的エッチングとラジカルの化学反応による化学的エッチングの組み合わされたエッチング法に基づき

化反応法、電界蒸着法、高周波イオンプレーティング法、反応性イオンプレーティング法等の各種イオンプレーティング法、
を挙げることができる。

【００４１】上記の第１の目的を達成するための本発明の電子放出装置は、（ａ）導電体層上に形成された金属若しくは金属化合物から成る島状の電子放出部形成領域、及び、（ｂ）該電子放出部形成領域上に形成された結晶性を有するグラファイトから成る電子放出部、を備えていることを特徴とする。

【００４２】本発明の電子放出装置あるいはその製造方法によって、冷陰極電界電子放出素子の電子放出部や、陰極線管や走査型電子顕微鏡に組み込まれる電子銃における電子線源、蛍光表示管を得ることができる。

【００４３】上記の第１の目的を達成するための本発明の第１の態様に係る冷陰極電界電子放出素子は、所謂２電極型の冷陰極電界電子放出表示装置を構成する冷陰極電界電子放出素子である。即ち、本発明の第１の態様に係る冷陰極電界電子放出素子は、（ａ）支持体上に設けられたカソード電極、（ｂ）カソード電極上に形成された島状の電子放出部形成領域、及び、（ｃ）電子放出部形成領域上に形成された電子放出部、を具備する冷陰極電界電子放出素子であって、該電子放出部形成領域は、金属若しくは金属化合物から成り、該電子放出部は、該電子放出部形成領域上に形成された結晶性を有するグラファイトから成ることを特徴とする。

【００４４】上記の第１の目的を達成するための本発明の第２の態様に係る冷陰極電界電子放出素子は、所謂３電極型の冷陰極電界電子放出表示装置を構成する冷陰極電界電子放出素子である。即ち、本発明の第２の態様に係る冷陰極電界電子放出素子は、（ａ）支持体上に設けられたカソード電極、（ｂ）カソード電極上に形成された島状の電子放出部形成領域、（ｃ）電子放出部形成領域上に形成された電子放出部、及び、（ｄ）電子放出部の上方に配設され、開口部を有するゲート電極、を具備する冷陰極電界電子放出素子であって、該電子放出部形成領域は、金属若しくは金属化合物から成り、該電子放出部は、該電子放出部形成領域上に形成された結晶性を有するグラファイトから成ることを特徴とする。

【００４５】上記の第１の目的を達成するための本発明た電子放出部、を具備し、該電子放出部形成領域は、金属若しくは金属化合物から成り、該電子放出部は、該電子放出部形成領域上に形成された結晶性を有するグラファイトから成ることを特徴とする。

【００４６】尚、本発明の第１の態様に係る冷陰極電界電子放出表示装置にあっては、アノード電極によって形成された電界に基づき、量子トンネル効果に基づき電子放出部から電子が放出され、この電子がアノード電極に引き付けられ、蛍光体層に衝突する。アノード電極は、１枚の導電材料シートが有効領域を覆う構造を有していてもよいし、ストライプ形状を有していてもよい。前者の場合、１画素を構成する電子放出部毎に、電子放出部の動作を制御する。そのためには、例えば、１画素を構成する電子放出部とカソード電極制御回路との間にスイッチング素子を設ければよい。後者の場合、カソード電極をストライプ状とし、アノード電極の射影像とカソード電極の射影像とが直交するように、カソード電極及びアノード電極を配置する。アノード電極の射影像とカソード電極の射影像とが重複する領域（以下、アノード電極／カソード電極重複領域と呼ぶ）に位置する複数の電子放出部から電子が放出される。尚、１アノード電極／カソード電極重複領域における冷陰極電界電子放出素子の配列は、基本的には、ランダムである。このような構成の冷陰極電界電子放出表示装置の駆動は、所謂単純マトリクス方式により行われる。即ち、カソード電極に相対的に負の電圧を印加し、アノード電極に相対的に正の電圧を印加する。その結果、列選択されたカソード電極と行選択されたアノード電極（あるいは、行選択されたカソード電極と列選択されたアノード電極）とのアノード電極／カソード電極重複領域に位置する電子放出部から選択的に真空空間中へ電子が放出され、この電子がアノード電極に引き付けられてアノードパネルを構成する蛍光体層に衝突し、蛍光体層を励起、発光させる。

【００４７】上記の第１の目的を達成するための本発明の第２の態様に係る冷陰極電界電子放出表示装置は、所謂３電極型の冷陰極電界電子放出表示装置である。即ち、本発明の第２の態様に係る冷陰極電界電子放出表示装置は、冷陰極電界電子放出素子が複数設けられたカソードパネル、及び、蛍光体層とアノード電極とを備えたアノードパネルが、それらの周縁部で接合されて成る冷

放出表示装置にあっては、ストライプ状のゲート電極の射影像とストライプ状のカソード電極の射影像とが直交する方向に延びていることが、冷陰極電界電子放出表示装置の構造の簡素化の観点から好ましい。尚、ストライプ状のカソード電極とストライプ状のゲート電極の射影像が重複する重複領域（電子放出領域であり、１画素分の領域あるいは１サブピクセル分の領域に相当する）に複数の冷陰極電界電子放出素子が設けられており、かかる重複領域（ゲート電極／カソード電極重複領域）が、カソードパネルの有効領域（実際の表示部分として機能する領域）内に、通常、２次元マトリクス状に配列されている。尚、１重複領域における冷陰極電界電子放出素子の配列は、基本的には、ランダムである。カソード電極に相対的に負の電圧を印加し、ゲート電極に相対的に正の電圧を印加し、アノード電極にゲート電極より更に高い正の電圧を印加する。列選択されたカソード電極と行選択されたゲート電極（あるいは、行選択されたカソード電極と列選択されたゲート電極）とのゲート電極／カソード電極重複領域に位置する複数の電子放出部から選択的に真空空間中へ電子が放出され、この電子がアノード電極に引き付けられてアノードパネルを構成する蛍光体層に衝突し、蛍光体層を励起、発光させる。

【００４９】本発明の電子放出装置、第１の態様若しくは第２の態様に係る冷陰極電界電子放出素子、あるいは又、本発明の第１の態様若しくは第２の態様に係る冷陰極電界電子放出表示装置においては、電子放出部形成領域の平均直径は1×10^{-9}m乃至1×10^{-7}m、好ましくは1×10^{-9}m乃至1×10^{-8}mであり、電子放出部形成領域の平均厚さは1×10^{-8}m乃至5×10^{-7}m、好ましくは1×10^{-8}m乃至1×10^{-7}mであることが望ましい。尚、得られた電子放出部の先端部の曲率半径は1×10^{-9}m乃至1×10^{-7}m、好ましくは1×10^{-9}m乃至1×10^{-8}mであることが望ましい。

【００５０】本発明の第２の態様に係る冷陰極電界電子放出素子若しくは本発明の第２の態様に係る冷陰極電界電子放出表示装置における冷陰極電界電子放出素子にあっては、支持体及びカソード電極の上に絶縁層が形成され、該絶縁層上に開口部を有するゲート電極が形成され、該絶縁層には、ゲート電極に設けられた開口部に連通した第２の開口部が形成され、絶縁層に形成された第

る冷陰極電界電子放出表示装置における冷陰極電界電子放出素子にあっては、絶縁材料から成る帯状あるいは井桁状のゲート電極支持部が支持体上に形成され、複数の開口部が形成された帯状材料から成るゲート電極が、ゲート電極支持部の頂面に接するように、且つ、電子放出部の上方に開口部が位置するように張架された構造とすることもできる。尚、このような構成を、便宜上、第２の構造を有する冷陰極電界電子放出素子と呼ぶ。この第２の構造を有する冷陰極電界電子放出素子は、本発明の第２Ｅの製造方法に基づき得ることができる。

【００５２】本発明の製造方法にあっては、電子放出部を形成するためのＣＶＤ法における原料ガスとして、炭化水素系ガスと水素ガスの組合せを用いることが好ましい。ここで、炭化水素系ガスとして、メタン（CH_4）、エタン（C_2H_6）、プロパン（C_3H_8）、ブタン（C_4H_{10}）、エチレン（C_2H_4）、アセチレン（C_2H_2）等の炭化水素系ガスやこれらの混合ガス、メタノール、エタノール、アセトン、ベンゼン、トルエン、キシレン、ナフタレン等を気化したガスを挙げることができる。また、放電を安定にさせるため及びプラズマ解離を促進するために、ヘリウム（Ｈｅ）やアルゴン（Ａｒ）等の希釈用ガスを混合してもよいし、窒素、アンモニア等のドーピングガスを混合してもよい。また、炭化水素系ガスと水素ガスの組合せを用いる場合、炭化水素系ガスと水素ガスの全流量に対する炭化水素系ガスの流量を１％乃至５０％、好ましくは５％乃至５０％とすることが望ましい。ここで、水素ガスは、形成されたグラファイト結晶粒子の内、結晶性の良くないグラファイト結晶粒子を除去（一種のエッチング）する役割を果たす。

【００５３】電子放出部を形成するためのＣＶＤ法にあっては、支持体にバイアス電圧を印加した状態で、プラズマ密度が10^{16}m^{-3}（10^{7}mm^{-3}）以上、好ましくは10^{17}m^{-3}（10^{8}mm^{-3}）以上、一層好ましくは10^{19}m^{-3}（10^{10}mm^{-3}）以上の条件のプラズマＣＶＤ法に基づくことが、電子放出部形成に用いる原料ガスの解離度を高くし、電子放出部を確実に形成するといった観点から好ましい。あるいは又、電子放出部を形成するためのＣＶＤ法は、支持体にバイアス電圧を印加した状態で、電子温度が１乃至１５ｅＶ、好ましくは５ｅＶ乃

ＣＶＤ法を挙げることができる。あるいは又、ホットフィラメントＣＶＤ法を採用してもよい。場合によっては、熱ＣＶＤ法を採用してもよい。尚、電子放出部を形成する工程における支持体加熱温度を、６００゜Ｃ以下、好ましくは５００゜Ｃ以下、更に好ましくは４００゜Ｃ以下、一層好ましくは３００゜Ｃ以下とすることができる。支持体加熱温度の下限は、電子放出部を形成し得る温度とすればよい。

【００５４】本発明の電子放出装置あるいはその製造方法、本発明の第１の態様若しくは第２の態様に係る冷陰極電界電子放出素子あるいはその製造方法、本発明の第１の態様若しくは第２の態様に係る冷陰極電界電子放出表示装置あるいはその製造方法（以下、これらを総称して、単に、本発明と呼ぶ場合がある）における結晶性を有するグラファイトは、ｓｐ^{2}結合を有するグラファイトから構成されており、１層のカーボングラファイトシートが巻かれた構造を有する単層カーボンナノチューブ、あるいは、２層以上のカーボングラファイトシートが巻かれた構造を有する所謂カーボンナノチューブである。あるいは又、カーボングラファイトシートが重なったカーボンナノファイバーや、カーボンナノチューブあるいはカーボンナノファイバーの周囲にアモルファスカーボンが堆積（付着）したものから構成されている。ｓｐ^{2}結合を有する炭素原子は、通常、６個の炭素原子から六員環を構成し、これらの六員環の集まりがカーボングラファイトシートを構成する。このカーボングラファイトシートが巻かれたチューブ構造を有するものがカーボンナノチューブである。一方、カーボングラファイトシートが巻かれておらず、カーボングラファイトのフラグメントが重なってファイバー状になったものが、カーボンナノファイバーである。場合によっては、円錐状の形状をも有し得る。電子放出部がどのような構造になるかは、ＣＶＤ条件や薄膜あるいは電子放出部形成領域を構成する材料等に依存する。１つの電子放出部形成領域に、１つのカーボンナノチューブから構成された電子放出部、１つのカーボンナノファイバーから構成された電子放出部、あるいは又、１つの円錐状の形状を有する電子放出部が形成される。言い換えれば、広くは、１つの電子放出部形成領域上に１つの結晶性を有するグラファイトの集合体（グラファイト結晶粒子の集合体）が形成

（Ａｇ）、金（Ａｕ）、インジウム（Ｉｎ）、マンガン（Ｍｎ）、パラジウム（Ｐｄ）及びタリウム（Ｔｌ）から成る群から選択された少なくとも１種類の金属、あるいは、これらの元素を含む金属化合物、合金を挙げることができるが、中でも、Ｎｉ、Ｍｏ、Ｔｉ、Ｃｏ、Ｆｅ、Ｐｔ、Ｚｎ、Ｐｂ、Ｐｄ、あるいは、これらの元素を含む金属化合物、合金を用いることが好ましい。更には、上記に挙げた金属以外でも、電子放出部を形成（合成）するときの雰囲気中で触媒作用を有する金属や金属化合物、合金を用いることができる。

【００５６】本発明の製造方法あるいは後述する本発明の薄膜のエッチング方法における溶媒として、純水、エチルアルコール、イソプロピルアルコール、アセトンを例示することができる。また、微粒子を分散させた溶媒を薄膜上に塗布する方法として、スピンコート法を例示することができる。場合によっては、スクリーン印刷法を採用することも可能である。溶媒を除去するためには、溶媒が蒸発する温度において乾燥を行えばよい。

【００５７】本発明の製造方法あるいは後述する本発明の薄膜のエッチング方法にあっては、微粒子の除去方法として、例えば、純水やエチルアルコール、イソプロピルアルコール、アセトン等に薄膜、微粒子等の全体を浸漬し、超音波洗浄を行う方法を挙げることができる。あるいは又、微粒子を構成する材料によっては、微粒子を溶解する液体に薄膜、微粒子等の全体を浸漬する方法や、微粒子を燃焼させる方法を例示することができる。

【００５８】第１の構造を有する冷陰極電界電子放出素子においては、ゲート電極に設けられた第１の開口部と第２の開口部とは、一対一の対応関係としてもよいし（即ち、１つの第１の開口部に対応して１つの第２の開口部を設けてもよいし）、多対一の対応関係としてもよい（即ち、多数の第１の開口部に対応して１つの第２の開口部を設けてもよい）。

【００５９】本発明の第２の態様に係る冷陰極電界電子放出素子あるいは本発明の第２の態様に係る冷陰極電界電子放出表示装置において、電子放出部形成領域、あるいは電子放出部形成領域及び電子放出部は、第２の開口部の底部に位置するカソード電極の表面に形成されていればよく、冷陰極電界電子放出素子の製造方法に依存して、第２の開口部の底部に位置するカソード電極の部分

ニングした後、第１のマスク材料層を除去し、次いで、導電材料層及び絶縁層上にパターニングされた第２のマスク材料層を形成し、かかる第２のマスク材料層をエッチング用マスクとして用いて導電材料層をエッチングして第１の開口部を形成する方法、あるいは又、例えば、スクリーン印刷法によって第１の開口部を有するゲート電極を直接形成する方法を例示することができる。これらの場合、ゲート電極に設けられた第１の開口部に連通する第２の開口部を絶縁層に形成する方法は、かかる第２のマスク材料層をエッチング用マスクとして用いて絶縁層をエッチングする方法としてもよいし、ゲート電極に設けられた第１の開口部をエッチング用マスクとして用いて絶縁層をエッチングする方法としてもよい。尚、第１の開口部と第２の開口部とは、一対一の対応関係としてもよいし（即ち、１つの第１の開口部に対応して１つの第２の開口部を形成してもよいし）、多対一の対応関係としてもよい（即ち、多数の第１の開口部に対応して１つの第２の開口部を形成してもよい）。更には、開口部を有するゲート電極を設ける工程は、ゲート電極を複数の開口部が形成された帯状の帯状材料層から構成し、絶縁層上に帯状材料層を張架してもよい。第２の開口部の形成は、等方的なエッチング（より具体的には、第２の開口部の側壁面を構成する絶縁層の部分の等方的なエッチング）、ケミカルドライエッチングのようにラジカルを主エッチング種として利用するドライエッチング、あるいは、エッチング液を利用するウェットエッチングにより行うことができる。

【００６１】電子放出部形成領域上における電子放出部の選択成長を一層確実なものとするために、電子放出部形成領域の表面の酸化物（所謂、自然酸化膜）を除去することが望ましい。酸化物の除去を、例えば、水素ガス雰囲気やアンモニアガス雰囲気におけるマイクロ波プラズマ法、トランス結合型プラズマ法、誘導結合型プラズマ法、電子サイクロトロン共鳴プラズマ法、ＲＦプラズマ法等に基づくプラズマ還元処理、アルゴンガス雰囲気におけるスパッタ処理、若しくは、例えばフッ酸等の酸や塩基を用いた洗浄処理によって行うことが望ましい。尚、本発明の電子放出装置を作製する場合にも、電子放出部形成領域を形成すべき導電体層の部分の表面に、以上に説明した各種工程を適用することができる。

カソード電極の射影像とストライプ状のゲート電極の射影像は、互いに直交することが好ましい。尚、これらの両電極の射影像が重複する部分に相当する領域（１画素分の領域に相当し、カソード電極とゲート電極との重複領域である）に、複数の電子放出部が位置する。更に、かかる重複領域が、カソードパネルの有効領域（実際の表示画面として機能する領域）内に、通常、２次元マトリクス状に配列されている。１画素内における冷陰極電界電子放出素子の配列は、基本的には、ランダムである。

【００６３】第２の構造を有する冷陰極電界電子放出素子若しくはその製造方法において、第１の開口部や第２の開口部の平面形状（カソード電極と平行な仮想平面でこれらの開口部を切断したときの形状）は、円形、楕円形、矩形、多角形、丸みを帯びた矩形、丸みを帯びた多角形等、任意の形状とすることができる。

【００６４】カソード電極の構造としては、導電材料層の１層構成とすることもできるし、下層導電材料層、下層導電材料層上に形成された抵抗体層、抵抗体層上に形成された上層導電材料層の３層構成とすることもできる。後者の場合、上層導電材料層の表面に電子放出部形成領域を形成する。あるいは又、カソード電極を、導電材料層と導電材料層上に形成された抵抗体層の２層構成とすることもできる。このように、抵抗体層を設けることによって、電子放出部の電子放出特性の均一化を図ることができる。抵抗体層を構成する材料として、シリコンカーバイド（ＳｉＣ）といったカーボン系材料、ＳｉＮ、アモルファスシリコン等の半導体材料、酸化ルテニウム（RuO_2）、酸化タンタル、窒化タンタル等の高融点金属酸化物を例示することができる。抵抗体層の形成方法として、スパッタリング法や、ＣＶＤ法やスクリーン印刷法を例示することができる。抵抗値は、概ね1×10^{5}～1×10^{7}Ω、好ましくは数ＭΩとすればよい。

【００６５】本発明の第２の態様に係る冷陰極電界電子放出素子の製造方法及び本発明の第２の態様に係る冷陰極電界電子放出表示装置の製造方法にあっては、絶縁層上にストライプ状を有するゲート電極を形成した後、絶縁層及びゲート電極上に、第２の絶縁層を形成し、この第２の絶縁層上に孔部を有する収束電極を形成し、次い

クの防止を可能とするための電極である。アノード電極とカソード電極との間の電位差が数キロボルトのオーダーであって、アノード電極とカソード電極との間の距離が比較的長い、所謂高電圧タイプの冷陰極電界電子放出表示装置において、収束電極は特に有効である。収束電極には、収束電源から相対的な負電圧が印加される。収束電極は、必ずしも冷陰極電界電子放出素子毎に設けられている必要はなく、例えば、冷陰極電界電子放出素子の所定の配列方向に沿って延在させることにより、複数の冷陰極電界電子放出素子に共通の収束効果を及ぼすこともできる。

【００６７】本発明の冷陰極電界電子放出素子若しくはその製造方法において、支持体は、少なくとも表面が絶縁性部材より構成されていればよく、ガラス基板、表面に絶縁膜が形成されたガラス基板、石英基板、表面に絶縁膜が形成された石英基板、表面に絶縁膜が形成された半導体基板を挙げることができるが、中でも、ガラス基板、表面に絶縁膜が形成されたガラス基板を用いることが、製造コスト低減といった観点から好ましい。基板も、支持体と同様に構成することができる。本発明の電子放出装置においても、導電体層を支持体上に形成する必要があるが、かかる支持体は絶縁材料から構成すればよい。

【００６８】導電体層、カソード電極、ゲート電極若しくは収束電極を構成する材料として、タングステン（Ｗ）、ニオブ（Ｎｂ）、タンタル（Ｔａ）、モリブデン（Ｍｏ）、クロム（Ｃｒ）、アルミニウム（Ａｌ）、銅（Ｃｕ）等の金属、これらの金属元素を含む合金あるいは化合物（例えばＴｉＮ等の窒化物や、WSi_2、$MoSi_2$、$TiSi_2$、$TaSi_2$等のシリサイド）、あるいはシリコン（Ｓｉ）等の半導体、ＩＴＯ（インジウム錫酸化物）を例示することができる。尚、これらの電極を構成する材料を、互いに同種材料としてもよいし、異種の材料としてもよい。これらの電極の形成方法として、蒸着法、スパッタ法、ＣＶＤ法、イオンプレーティング法、スクリーン印刷法、メッキ法等、通常の薄膜作製プロセスを利用できる。

【００６９】尚、ゲート電極若しくは収束電極を構成する材料と、薄膜あるいは電子放出部形成領域を構成する材料とは、ゲート電極若しくは収束電極上に電子放出部をＣＶＤ法にて電子放出部を形成するときのＣＶＤ条件においてグラファイトが形成されないような材料から導電体層やカソード電極を形成する必要がある。

【００７０】絶縁層や第２の絶縁層の構成材料としては、SiO_2、ＳｉＮ、ＳｉＯＮ、ガラスペースト硬化物を単独あるいは適宜組み合わせて使用することができる。絶縁層の形成には、ＣＶＤ法、塗布法、スパッタ法、スクリーン印刷法等の公知のプロセスが利用できる。

【００７１】アノード電極の構成材料は、冷陰極電界電子放出表示装置の構成によって選択すればよい。即ち、冷陰極電界電子放出表示装置が透過型（アノードパネルが表示面に相当する）であって、且つ、基板上にアノード電極と蛍光体層がこの順に積層されている場合には、アノード電極が形成される基板は元より、アノード電極自身も透明である必要があり、ＩＴＯ（インジウム錫酸化物）等の透明導電材料を用いる。一方、冷陰極電界電子放出表示装置が反射型（カソードパネルが表示面に相当する）である場合、及び、透過型であっても基板上に蛍光体層とアノード電極とがこの順に積層されている（アノード電極はメタルバック膜を兼ねている）場合には、ＩＴＯの他、カソード電極やゲート電極や収束電極に関連して上述した材料を適宜選択して用いることができる。

【００７２】蛍光体層を構成する蛍光体として、高速電子励起用蛍光体や低速電子励起用蛍光体を用いることができる。冷陰極電界電子放出表示装置が単色表示装置である場合、蛍光体層は特にパターニングされていなくともよい。また、冷陰極電界電子放出表示装置がカラー表示装置である場合、ストライプ状又はドット状にパターニングされた赤（Ｒ）、緑（Ｇ）、青（Ｂ）の三原色に対応する蛍光体層を交互に配置することが好ましい。尚、パターニングされた蛍光体層間の隙間は、表示画面のコントラスト向上を目的としたブラックマトリックスで埋め込まれていてもよい。

【００７３】アノード電極と蛍光体層の構成例として、（１）基板上に、アノード電極を形成し、アノード電極の上に蛍光体層を形成する構成、（２）基板上に、蛍光体層を形成し、蛍光体層上にアノード電極を形成する構成、を挙げることができる。尚、（１）の構成におい

としてもよい。

【００７５】本発明の第１の態様及び第２の態様に係る冷陰極電界電子放出表示装置の製造方法において、基板と支持体とを周縁部において接合する場合、接合は接着層を用いて行ってもよいし、あるいはガラスやセラミック等の絶縁剛性材料から成る枠体と接着層とを併用して行ってもよい。枠体と接着層とを併用する場合には、枠体の高さを適宜選択することにより、接着層のみを使用する場合に比べ、基板と支持体との間の対向距離をより長く設定することが可能である。尚、接着層の構成材料としては、フリットガラスが一般的であるが、融点が１２０～４００゜Ｃ程度の所謂低融点金属材料を用いてもよい。かかる低融点金属材料としては、Ｉｎ（インジウム：融点１５７゜Ｃ）；インジウム－金系の低融点合金；$Sn_{80}Ag_{20}$（融点２２０～３７０゜Ｃ）、$Sn_{95}Cu_{5}$（融点２２７～３７０゜Ｃ）等の錫（Ｓｎ）系高温はんだ；$Pb_{97.5}Ag_{2.5}$（融点３０４゜Ｃ）、$Pb_{98.5}Ag_{1.5}$（融点３０４～３６５゜Ｃ）、$Pb_{97.5}Ag_{1.5}Sn_{1.0}$（融点３０９゜Ｃ）等の鉛（Ｐｂ）系高温はんだ；$Zn_{95}Al_{5}$（融点３８０゜Ｃ）等の亜鉛（Ｚｎ）系高温はんだ；$Sn_{5}Pb_{95}$（融点３００～３１４゜Ｃ）、$Sn_{2}Pb_{98}$（融点３１６～３２２゜Ｃ）等の錫－鉛系標準はんだ；$Au_{88}Ga_{12}$（融点３８１゜Ｃ）等のろう材（以上の添字は全て原子％を表す）を例示することができる。

【００７６】基板と支持体と枠体の三者を接合する場合、三者同時接合を行ってもよいし、あるいは、第１段階で基板又は支持体のいずれか一方と枠体とを先に接合し、第２段階で基板又は支持体の他方と枠体とを接合してもよい。三者同時接合や第２段階における接合を高真空雰囲気中で行えば、基板と支持体と枠体と接着層とにより囲まれた空間は、接合と同時に真空となる。あるいは、三者の接合終了後、基板と支持体と枠体と接着層とによって囲まれた空間を排気し、真空とすることもできる。接合後に排気を行う場合、接合時の雰囲気の圧力は常圧／減圧のいずれであってもよく、また、雰囲気を構成する気体は、大気であっても、あるいは窒素ガスや周期律表０族に属するガス（例えばＡｒガス）を含む不活性ガスであってもよい。

【００７７】接合後に排気を行う場合、排気は、基板及

適である。

【００７８】上記の第２の目的を達成するための本発明の薄膜のエッチング方法は、薄膜上に微粒子を配置した後、該微粒子をエッチング用マスクとして薄膜に対して異方性エッチングを行い、微粒子の下に位置する薄膜を選択的に残し、次いで、微粒子を除去することを特徴とする。

【００７９】本発明の薄膜のエッチング方法にあっては、薄膜上への微粒子の配置を、微粒子を分散させた溶媒を薄膜上に塗布した後、溶媒を除去する方法にて行うことが好ましい。また、薄膜を、ＣＶＤ法、先に例示したＰＶＤ法、又は、メッキ法（電解メッキ法及び無電解メッキ法を含む）にて形成することが望ましい。微粒子は、コロイダルシリカを含むシリカ又はアルミナから成ることが好ましい。更には、エッチングを、イオン照射による物理的エッチングとラジカルの化学反応による化学的エッチングの組み合わされたエッチング法に基づき行うことが、異方性エッチングの達成といった観点から望ましい。尚、微粒子の平均直径として、1×10^{-9}ｍ乃至1×10^{-7}ｍ、好ましくは1×10^{-9}ｍ乃至1×10^{-8}ｍを例示することができ、薄膜の平均厚さとして、1×10^{-9}ｍ乃至5×10^{-7}ｍ、好ましくは1×10^{-9}ｍ乃至1×10^{-7}ｍを例示することができる。また、薄膜の法線方向における薄膜のエッチング速度をER_1、薄膜の法線方向における微粒子のエッチング速度をER_2としたとき、$ER_2 \leqq 0.1ER_1$、好ましくは$ER_2 \leqq 0.01ER_1$を満足することが望ましい。微粒子及び薄膜を構成する材料を適宜選択し、且つ、エッチング条件を適切に設定することによって、$ER_2 \leqq 0.1ER_1$を満足させることができる。

【００８０】本発明の薄膜のエッチング方法においては、薄膜は基体上に形成されている。ここで、基体や薄膜を構成する材料は、本質的に任意である。また、本発明の薄膜のエッチング方法の適用分野も、本質的に任意である。

【００８１】本発明の電子放出装置及びその製造方法、冷陰極電界電子放出素子及びその製造方法、並びに、冷陰極電界電子放出表示装置及びその製造方法においては、微粒子の径を適切に選択することによって、微細な電子放出部形成領域を得ることができる結果、電子を放

の電子放出装置及びその製造方法、第１の態様に係る冷陰極電界電子放出素子（以下、電界放出素子と略称する）及びその製造方法、第１の態様に係る所謂２電極型の冷陰極電界電子放出表示装置（以下、表示装置と略称する）及びその製造方法、並びに、本発明の薄膜のエッチング方法に関する。

【００８４】実施の形態１の表示装置の模式的な一部断面図を図１に示し、１つの電界放出素子の模式的な一部断面図を図２の（Ｄ）に示す。尚、図面においては、電子放出部を規則的に表示したが、実際にはランダムな位置に形成されている。他の図面においても同様である。

【００８５】実施の形態１における電子放出装置は、導電体層上に形成された金属（具体的には、実施の形態１においてはニッケル）から成る島状の電子放出部形成領域２２、及び、電子放出部形成領域２２上に形成された結晶性を有するグラファイト（より具体的には、ｓｐ^{2}結合を有するグラファイトから構成されたカーボンナノチューブ）から成る電子放出部１５を備えている。

【００８６】また、実施の形態１における電界放出素子は、支持体１０上に設けられたカソード電極１１と、カソード電極１１上に形成された島状の電子放出部形成領域２２と、電子放出部形成領域２２上に形成された電子放出部１５を具備する。即ち、カソード電極１１（あるいは導電体層）を海に見立てたとき、電子放出部形成領域２２が島状に点在している。そして、電子放出部形成領域２２は、金属（具体的には、実施の形態１においてはニッケル）から成り、電子放出部１５は、電子放出部形成領域２２上に形成された結晶性を有するグラファイト（より具体的には、ｓｐ^{2}結合を有するグラファイトから構成されたカーボンナノチューブ）から構成されている。カソード電極１１の平面形状はストライプ形状である。更には、実施の形態１における表示装置は、電界放出素子が複数設けられたカソードパネルＣＰ、及び、蛍光体層３１（赤色発光蛍光体層３１Ｒ、緑色発光蛍光体層３１Ｇ、青色発光蛍光体層３１Ｂ）とアノード電極３３とを備えたアノードパネルＡＰが、それらの周縁部で接合されて成り、複数の画素を有する。アノード電極３３はストライプ状である。ストライプ状のカソード電極１１の射影像とストライプ状のアノード電極３３の射影像とは直交する。具体的には、カソード電極１１は図台によっては、枠体３４の代わりに接着層のみを用いることもできる。

【００８８】アノードパネルＡＰは、具体的には、基板３０と、基板３０上に形成され、所定のパターン（例えば、ストライプ状やドット状）に従って形成された蛍光体層３１と、蛍光体層３１を覆う例えばアルミニウム薄膜から成るストライプ状のアノード電極３３から構成されている。蛍光体層３１と蛍光体層３１との間の基板３０上には、ブラックマトリックス３２が形成されている。尚、ブラックマトリックス３２を省略することもできる。また、単色表示装置を想定した場合、蛍光体層３１は必ずしも所定のパターンに従って設けられる必要はない。更には、ＩＴＯ等の透明導電膜から成るアノード電極を基板３０と蛍光体層３１との間に設けてもよく、あるいは、基板３０上に設けられた透明導電膜から成るアノード電極３３と、アノード電極３３上に形成された蛍光体層３１及びブラックマトリックス３２と、蛍光体層３１及びブラックマトリックス３２の上に形成されたアルミニウムから成り、アノード電極３３と電気的に接続された光反射導電膜から構成することもできる。

【００８９】１画素は、カソードパネル側においてストライプ状のカソード電極１１と、その上に形成された電子放出部１５と、電子放出部１５に対面するようにアノードパネルＡＰの有効領域に配列された蛍光体層３１とによって構成されている。有効領域には、かかる画素が、例えば数十万～数百万個ものオーダーにて配列されている。

【００９０】また、カソードパネルＣＰとアノードパネルＡＰとの間には、両パネル間の距離を一定に維持するための補助的手段として、有効領域内に等間隔にスペーサ３５が配置されている。尚、スペーサ３５の形状は、円柱形に限らず、例えば球状でもよいし、ストライプ状の隔壁（リブ）であってもよい。また、スペーサ３５は、必ずしも全てのカソード電極の重複領域の四隅に配置されている必要はなく、より疎に配置されていてもよいし、配置が不規則であってもよい。

【００９１】この表示装置においては、アノード電極３３によって形成された電界に基づき、量子トンネル効果に基づき電子放出部１５から電子が放出され、この電子がアノード電極３３に引き付けられ、蛍光体層３１に衝

アノード電極３３）とのアノード電極／カソード電極重複領域に位置する電子放出部１５から選択的に真空空間中へ電子が放出され、この電子がアノード電極３３に引き付けられてアノードパネルＡＰを構成する蛍光体層３１に衝突し、蛍光体層３１を励起、発光させる。

【００９２】以下、実施の形態１における電子放出装置、電界放出素子及び表示装置の製造方法、薄膜のエッチング方法を、支持体等の模式的な一部断面図である図２、及び、基板等の模式的な一部断面図である図３を参照して説明する。

【００９３】［工程－１００］先ず、支持体１０上にカソード電極１１を形成する。具体的には、例えば、ガラス基板から成る支持体１０上にレジスト材料から成るマスク層を形成する。マスク層は、ストライプ状のカソード電極を形成すべき部分以外の支持体１０を被覆するように形成する。次いで、Ｃｒ、Ａｌ、ＭｏあるいはＴａ等から成る導電体層をスパッタ法にて全面に成膜する。その後、マスク層並びにその上の導電体層を除去することによって、ストライプ状のカソード電極１１を形成することができる。カソード電極１１は図２の紙面左右方向に延びている。尚、このようなリフトオフ法に代えて、カソード電極を構成する導電体層の成膜、リソグラフィ技術とドライエッチング技術に基づく導電体層のパターニングによって、ストライプ状のカソード電極１１を形成してもよい。

【００９４】［工程－１１０］その後、スパッタ法にて全面にニッケル（Ｎｉ）から成る平均厚さ１０ｎｍの薄膜２０を形成した後、電子放出部を形成すべき薄膜２０の部分を残すようなパターニングをリソグラフィ技術及びエッチング技術に基づき行う。こうして、図２の（Ａ）に示す構造を得ることができる。

【００９５】［工程－１２０］その後、薄膜２０上に微粒子２１を配置する。具体的には、平均粒径１０ｎｍのコロイダルシリカをイソプロピルアルコールから成る溶媒に分散させた溶液をスピンコート法にて全面に塗布した後、乾燥して溶媒を除去する。こうして、図２の（Ｂ）に示す状態を得ることができる。溶液中の微粒子の量によって、薄膜２０上の微粒子２１の配置密度を制御することができる。尚、コロイダルシリカは、溶媒中に分散してコロイド状となり、薄膜２０上に配置（塗反応性イオンエッチング（ＲＩＥ）法にて、微粒子２１をエッチング用マスクとして薄膜２０をエッチングして微粒子２１の下に位置する薄膜２０を選択的に残す（図２の（Ｃ）参照）。次いで、微粒子２１を除去し、残された薄膜２０から成る島状の電子放出部形成領域２２を形成する。例えば、イソプロピルアルコールに支持体全体を浸漬し、超音波洗浄を行うことによって、微粒子２１を除去することができる。尚、表１に示す条件にあっては、薄膜２０の法線方向における薄膜２０のエッチング速度をER_1、薄膜２０の法線方向における微粒子２１のエッチング速度をER_2としたとき、$ER_2 \approx 0.1 ER_1$を満足している。

【００９７】［表１］

エッチング装置	：平行平板ＲＩＥ装置
エッチングガス	：Cl_2＝１００ＳＣＣＭ
圧力	：０．４Ｐａ
ＲＦパワー	：１～２ｋＷ（１３．５６ＭＨｚ）
エッチング温度	：４００～５００゜Ｃ

【００９８】［工程－１４０］その後、マイクロ波プラズマＣＶＤ法にて、選択的に電子放出部形成領域２２上に結晶性を有するグラファイトから成る電子放出部１５を形成する。電子放出部１５の形成条件を、以下の表２に例示する。こうして、図２の（Ｄ）に示すように、電界放出素子あるいは電子放出装置を得ることができる。

【００９９】［表２］

原料ガス	：CH_4／H_2＝５０／５０sccm
圧力	：２Ｐａ
マイクロ波パワー	：３ｋＷ
支持体温度	：４００゜Ｃ
プラズマ密度	：1×10^{11}／cm^3
電子温度	：１０ｅＶ
イオン電流密度	：２０ｍＡ／cm^2

【０１００】［工程－１５０］その後、表示装置の組み立てを行う。具体的には、蛍光体層３１と電界放出素子とが対向するようにアノードパネルＡＰとカソードパネルＣＰとを配置し、アノードパネルＡＰとカソードパネルＣＰ（より具体的には、基板３０と支持体１０）とを、枠体３４を介して、周縁部において接合する。接合に際しては、枠体３４とアノードパネルＡＰとの接合部位、及び枠体３４とカソードパネルＣＰとの接合部位に

ができる。その後、必要な外部回路との配線を行い、表示装置を完成させる。

【０１０１】得られた電子放出部１５を走査型電子顕微鏡で観察したところ、電子放出部１５は、直径約１０ｎｍ、先端部の曲率半径が平均約５ｎｍのカーボンナノチューブから構成されており、電子放出部形成領域２２の頂面からカーボンナノチューブが上方に向かって柱状に延びていることが観察された。得られた表示装置からの電子放出特性を評価したところ、表示装置全面からの電子放出を確認できた。尚、この表示装置の閾値電位$ΔV_{th}$は、従来のスピント型電界放出素子を組み込んだ表示装置における閾値電位$ΔV_{th}$の約５０％であった。

【０１０２】尚、図１に示した表示装置におけるアノードパネルＡＰの製造方法の一例を、以下、図３を参照して説明する。

【０１０３】先ず、発光性結晶粒子組成物を調製する。そのために、例えば、純水に分散剤を分散させ、ホモミキサーを用いて３０００ｒｐｍにて１分間、撹拌を行う。次に、発光性結晶粒子を分散剤が分散した純水中に投入し、ホモミキサーを用いて５０００ｒｐｍにて５分間、撹拌を行う。その後、例えば、ポリビニルアルコール及び重クロム酸アンモニウムを添加して、十分に撹拌し、濾過する。

【０１０４】アノードパネルＡＰの製造においては、例えばガラスから成る基板３０上の全面に感光性被膜５０を形成（塗布）する。そして、露光光源（図示せず）から射出され、マスク５３に設けられた孔部５４を通過した紫外線によって、基板３０上に形成された感光性被膜５０を露光して感光領域５１を形成する（図３の（Ａ）参照）。その後、感光性被膜５０を現像して選択的に除去し、感光性被膜の残部（露光、現像後の感光性被膜）５２を基板３０上に残す（図３の（Ｂ）参照）。次に、全面にカーボン剤（カーボンスラリー）を塗布し、乾燥、焼成した後、リフトオフ法にて感光性被膜の残部５２及びその上のカーボン剤を除去することによって、露出した基板３０上にカーボン剤から成るブラックマトリックス３２を形成し、併せて、感光性被膜の残部５２を除去する（図３の（Ｃ）参照）。その後、露出した基板３０上に、赤、緑、青の各蛍光体層３１を形成する（図３の（Ｄ）参照）。具体的には、各発光性結晶粒子（蛍スクリーン印刷法等により各蛍光体層３１を形成することもできる。

【０１０５】尚、１画素を、カソードパネル側において矩形形状のカソード電極１１と、その上に形成された電子放出部１５と、電子放出部１５に対面するようにアノードパネルＡＰの有効領域に配列された蛍光体層３１とによって構成してもよい。この場合の１つの電子放出部におけるカソード電極１１の模式的な斜視図を図４に示す。このような表示装置においては、１画素単位で、カソード電極１１に印加する電圧の制御を行う。カソード電極１１の平面形状は、図４に模式的に示すように、略矩形であり、各カソード電極１１は、配線１１Ａ、及び、例えばトランジスタから成るスイッチング素子（図示せず）を介してカソード電極制御回路４０に接続されている。また、アノード電極３３はアノード電極制御回路４２に接続されている。アノード電極３３は、１枚の導電材料シートが有効領域を覆う構造を有していればよい。場合によっては、１又は複数の電子放出部、あるいは、１又は複数の画素に対応するアノード電極ユニットが集合した形式のアノード電極としてもよい。各カソード電極１１に閾値電圧以上の電圧が印加されると、アノード電極３３によって形成される電界に基づき、量子トンネル効果に基づき電子放出部１５から電子が放出され、この電子がアノード電極３３に引き付けられ、蛍光体層３１に衝突する。輝度は、カソード電極１１に印加される電圧によって制御される。

【０１０６】このような構造の電界放出素子の製造にあたっては、［工程－１００］において、例えばシリコン半導体基板から成る支持体１０上にカソード電極形成用の導電体層を形成する。次いで、周知のリソグラフィ技術及び反応性イオンエッチング法（ＲＩＥ法）に基づき、導電体層をパターニングすることによって、矩形形状のカソード電極１１を支持体１０上に形成する。同時に、カソード電極１１に接続された配線１１Ａ（図４参照）を支持体１０上に形成する。その後、［工程－１１０］～［工程－１４０］を実行することで電界放出素子を得ることができ、更に、［工程－１５０］を実行することで表示装置を得ることができる。

【０１０７】（実施の形態２）実施の形態２は、実施の形態１の変形である。実施の形態１にて説明した製造方

下．実施の形態２の電界放出素子の製造方法及び表示装置の製造方法を説明する。

【０１０９】［工程－２００］先ず．実施の形態１の［工程－１００］～［工程－１３０］と同様の工程を実行する。

【０１１０】［工程－２１０］次に．電子放出部形成領域２２の表面の金属酸化物（自然酸化膜）を、以下の表３に例示するプラズマ還元処理（マイクロ波プラズマ処理）に基づき除去する。あるいは又．例えば５０％フッ酸水溶液と純水の１：４９（容積比）混合液を用いて、露出した電子放出部形成領域２２の表面の金属酸化物（自然酸化膜）を除去することもできる。

【０１１１】［表3］

使用ガス	：H_2＝１００SCCM
圧力	：１．３×10^{3}Pa
マイクロ波パワー	：６００W（１３．５６MHz）
処理温度	：４００゜C

【０１１２】［工程－２２０］その後．実施の形態１の［工程－１４０］と同様の工程を実行して電界放出素子を製造し、更に．実施の形態１の［工程－１５０］と同様にして、表示装置の組み立てを行う。尚、マイクロ波プラズマCVD法にて、選択的に電子放出部形成領域２２上に結晶性を有するグラファイトから成る電子放出部１５を形成する。

【０１１３】実施の形態２においては．電子放出部形成領域２２の表面の金属酸化物（自然酸化膜）を除去した後．かかる電子放出部形成領域２２の表面に電子放出部１５を形成するので、より一層低い温度での電子放出部１５の形成が可能となる。

【０１１４】（実施の形態３）実施の形態３は．本発明の電子放出装置及びその製造方法、第２の態様に係る電界放出素子及びその製造方法（第２Aの製造方法）、第２の態様に係る所謂３電極型の表示装置及びその製造方法．並びに、本発明の薄膜にエッチング方法に関する。尚．実施の形態３における電界放出素子は第１の構造を有する。

【０１１５】実施の形態３の電界放出素子の模式的な一部端面図を図８に示し、表示装置の模式的な一部端面図を図５に示し．カソードパネルCPとアノードパネルAPを分解したときの模式的な部分的斜視図を図６に示し．開口部１４Bが絶縁層１２に設けられており．第２の開口部１４Bの底部に電子放出部１５が位置する。

【０１１６】表示装置は．上述のような電界放出素子が有効領域に多数形成されたカソードパネルCPと．アノードパネルAPから構成されており．複数の画素から構成され、各画素は、電界放出素子と．電界放出素子に対向して基板３０上に設けられたアノード電極３３及び蛍光体層３１から構成されている。カソードパネルCPとアノードパネルAPとは．それらの周縁部において、枠体３４を介して接合されている。図５に示す一部端面図には．カソードパネルCPにおいて．１本のカソード電極１１につき開口部１４A．１４B及び電子放出部１５を．図面の簡素化のために２つずつ示しているが．これに限定するものではなく．また、電界放出素子の基本的な構成は図８に示したとおりである。更には、カソードパネルCPの無効領域には．真空排気用の貫通孔３６が設けられており．この貫通孔３６には．真空排気後に封じ切られるチップ管３７が接続されている。但し．図５は表示装置の完成状態を示しており．図示したチップ管３７は既に封じ切られている。また．スペーサの図示は省略した。

【０１１７】アノードパネルAPの構造は、実施の形態１にて説明したアノードパネルAPと同様の構造とすることができるので、詳細な説明は省略する。但し．アノード電極３３は．１枚の導電材料シートが有効領域を覆う構造を有している。

【０１１８】この表示装置において表示を行う場合には．カソード電極１１には相対的な負電圧がカソード電極制御回路４０から印加され、ゲート電極１３には相対的な正電圧がゲート電極制御回路４１から印加され、アノード電極３３にはゲート電極１３よりも更に高い正電圧がアノード電極制御回路４２から印加される。かかる表示装置において表示を行う場合、例えば、カソード電極１１にカソード電極制御回路４０から走査信号を入力し．ゲート電極１３にゲート電極制御回路４１からビデオ信号を入力する。尚、これとは逆に．カソード電極１１にカソード電極制御回路４０からビデオ信号を入力し．ゲート電極１３にゲート電極制御回路４１から走査信号を入力してもよい。カソード電極１１とゲート電極１３との間に電圧を印加した際に生ずる電界により．電

行することによって、カソード電極１１上に形成された電子放出部形成領域２２上に結晶性を有するグラファイトから成る電子放出部１５をＣＶＤ法にて選択的に形成することができる。尚、［工程－１１０］と同様の工程においては、場合によっては薄膜２０のパターニングは不要であり、あるいは又、カソード電極１１の全面に薄膜２０を残すようなパターニングをリソグラフィ技術及びエッチング技術に基づき行ってもよい。あるいは又、［工程－１００］及び［工程－１１０］に代えて、以下の工程を実行してもよい。即ち、ガラス基板から成る支持体１０上にレジスト材料から成るマスク層を形成する。マスク層を、ストライプ状のカソード電極を形成すべき部分以外の支持体１０を被覆するように形成する。次いで、導電体層、薄膜をスパッタ法にて順次、全面に成膜する。その後、マスク層並びにその上の薄膜及び導電体層を除去することによって、ストライプ状のカソード電極１１と薄膜２０の積層構造を得ることができる。このような工程も、支持体上にカソード電極を形成する工程、及び、カソード電極上に金属若しくは金属化合物から成る薄膜を形成する工程に包含される。

【０１２１】［工程－３１０］次に、全面に、具体的には、支持体１０、カソード電極１１及び電子放出部１５上に絶縁層１２を形成する（図７の（Ａ）参照）。具体的には、例えばＴＥＯＳ（テトラエトキシシラン）を原料ガスとして使用するＣＶＤ法により、全面に、厚さ約３μｍの絶縁層１２を形成する。尚、例えば、スパッタ法やスクリーン印刷法にて絶縁層１２を形成してもよい。その後、絶縁層１２上に第１の開口部１４Ａを有するゲート電極１３を形成する。具体的には、絶縁層１２上にゲート電極を構成するための導電材料層（カソード電極１１を構成する材料と同じ材料である）をスパッタ法にて形成した後、導電材料層上にパターニングされたマスク材料層（図示せず）を形成し、かかるマスク材料層をエッチング用マスクとして用いて導電材料層をエッチングして、導電材料層をストライプ状にパターニングした後、マスク材料層を除去する。次いで、導電材料層及び絶縁層１２上にパターニングされたレジスト材料層を形成し、かかるレジスト材料層をエッチング用マスクとして用いて導電材料層をエッチングする。これによって、絶縁層１２上に第１の開口部１４Ａを有するゲート第１の開口部１４Ａに対応して、１つの第２の開口部１４Ｂが形成される。尚、第１及び第２の開口部１４Ａ，１４Ｂの平面形状は、例えば直径１μｍ～３０μｍの円形である。これらの開口部１４Ａ，１４Ｂを、例えば、１画素に１個～３０００個程度形成すればよい。

【０１２２】［工程－３２０］その後、絶縁層１２に設けられた第２の開口部１４Ｂの側壁面を等方的なエッチングによって後退させることが、ゲート電極１３の開口端部を露出させるといった観点から、好ましい。こうして、図８に示す電界放出素子を完成することができる。尚、等方的なエッチングは、ケミカルドライエッチングのようにラジカルを主エッチング種として利用するドライエッチング、あるいはエッチング液を利用するウェットエッチングにより行うことができる。エッチング液としては、例えば４９％フッ酸水溶液と純水の１：１００（容積比）混合液を用いることができる。

【０１２３】［工程－３３０］その後、実施の形態１の［工程－１５０］と同様にして、表示装置の組み立てを行う。

【０１２４】得られた電子放出部１５を走査型電子顕微鏡で観察したところ、電子放出部１５は、直径約１０ｎｍ、先端部の曲率半径が平均約５ｎｍのカーボンナノチューブから構成されており、電子放出部形成領域２２の頂面からカーボンナノチューブが上方に向かって柱状に延びていることが観察された。得られた表示装置からの電子放出特性を評価したところ、表示装置全面からの電子放出を確認できた。尚、この表示装置の閾値電位ΔV_{th}は、従来のスピント型電界放出素子を組み込んだ表示装置における閾値電位ΔV_{th}の約５０％であった。

【０１２５】尚、電子放出部形成領域２２及び電子放出部１５は、第２の開口部１４Ｂの底部に位置するカソード電極１１の表面に形成されていればよく、場合によっては、第２の開口部１４Ｂの底部に位置するカソード電極１１の部分から第２の開口部１４Ｂの底部以外の絶縁層１２で被覆されたカソード電極１１の部分に延在するように形成されていてもよい。

【０１２６】また、実施の形態２にて説明した電子放出部形成領域２２の表面の金属酸化物（所謂、自然酸化膜）を除去する方法を実施の形態３に適用することもできる。以下に説明する実施の形態においても同様であ

である図９及び図１０を参照して説明する。

【０１２９】［工程－４００］先ず、実施の形態１の［工程－１００］～［工程－１１０］と同様の工程を実行する。尚、［工程－１１０］と同様の工程においては、場合によっては薄膜２０のパターニングは不要であり、あるいは又、カソード電極１１の全面に薄膜２０を残すようなパターニングをリソグラフィ技術及びエッチング技術に基づき行ってもよい。あるいは又、［工程－１００］及び［工程－１１０］に代えて、以下の工程を実行してもよい。即ち、ガラス基板から成る支持体１０上にレジスト材料から成るマスク層を形成する。マスク層を、ストライプ状のカソード電極を形成すべき部分以外の支持体１０を被覆するように形成する。次いで、導電体層、薄膜をスパッタ法にて順次、全面に成膜する。その後、マスク層並びにその上の薄膜及び導電体層を除去することによって、ストライプ状のカソード電極１１と薄膜２０の積層構造を得ることができる。このような工程も、支持体上にカソード電極を形成する工程、及び、カソード電極上に金属若しくは金属化合物から成る薄膜を形成する工程に包含される。

【０１３０】［工程－４１０］次に、実施の形態３の［工程－３１０］と同様にして、全面に絶縁層１２を形成し、次いで、第１の開口部１４Ａを有するゲート電極１３を形成し、更に、絶縁層１２に第２の開口部１４Ｂを形成して、第２の開口部１４Ｂの底部に薄膜２０を露出させる（図９の（Ａ）参照）。

【０１３１】［工程－４２０］次いで、実施の形態１の［工程－１２０］と同様にして、図９の（Ｂ）に示すように、薄膜２０上に微粒子２１を配置する。具体的には、全面に微粒子２１を配置する。

【０１３２】［工程－４３０］その後、実施の形態１の［工程－１３０］と同様にして、微粒子２１をエッチング用マスクとして薄膜２０に対して異方性エッチングを行い、微粒子２１の下に位置する薄膜２０を選択的に残す（図１０の（Ａ）参照）。次いで、微粒子２１を除去し、以て、残された薄膜２０から成る島状の電子放出部形成領域２２を形成する。

【０１３３】［工程－４４０］次いで、実施の形態１の［工程－１４０］と同様にして、ＣＶＤ法に基づき、選択的に電子放出部形成領域２２上に結晶性を有するグラ

【０１３６】実施の形態５の表示装置は、実施の形態３の表示装置と同じ構造を有しているので、詳細な説明は省略する。以下、実施の形態５の電子放出装置の製造方法、電界放出素子の製造方法（第２Ｃの製造方法）及び表示装置の製造方法を、支持体等の模式的な一部端面図である図１１及び図１２を参照して説明する。

【０１３７】［工程－５００］先ず、実施の形態１の［工程－１００］～［工程－１１０］と同様の工程を実行する。尚、［工程－１１０］と同様の工程においては、場合によっては薄膜２０のパターニングは不要であり、あるいは又、カソード電極１１の全面に薄膜２０を残すようなパターニングをリソグラフィ技術及びエッチング技術に基づき行ってもよい。あるいは又、［工程－１００］及び［工程－１１０］に代えて、以下の工程を実行してもよい。即ち、ガラス基板から成る支持体１０上にレジスト材料から成るマスク層を形成する。マスク層を、ストライプ状のカソード電極を形成すべき部分以外の支持体１０を被覆するように形成する。次いで、導電体層、薄膜をスパッタ法にて順次、全面に成膜する。その後、マスク層並びにその上の薄膜及び導電体層を除去することによって、ストライプ状のカソード電極１１と薄膜２０の積層構造を得ることができる。このような工程も、支持体上にカソード電極を形成する工程、及び、カソード電極上に金属若しくは金属化合物から成る薄膜を形成する工程に包含される。

【０１３８】［工程－５１０］次いで、実施の形態１の［工程－１２０］と同様にして、薄膜２０上に微粒子２１を配置する。具体的には、全面に微粒子２１を配置する。その後、実施の形態１の［工程－１３０］と同様にして、微粒子２１をエッチング用マスクとして薄膜２０に対して異方性エッチングを行い、微粒子２１の下に位置する薄膜２０を選択的に残した後、微粒子２１を除去し、以て、残された薄膜２０から成る島状の電子放出部形成領域２２を形成する（図１１の（Ａ）参照）。

【０１３９】［工程－５２０］次に、実施の形態３の［工程－３１０］と同様にして、全面に絶縁層１２を形成し（図１１の（Ｂ）参照）、次いで、第１の開口部１４Ａを有するゲート電極１３を形成し、更に、絶縁層１２に第２の開口部１４Ｂを形成して、第２の開口部１４Ｂの底部にカソード電極１１及び電子放出部形成領域２

【０１４２】（実施の形態６）実施の形態６も、実施の形態３の変形であり、第２Ｄの製造方法に関する。尚、実施の形態６における電界放出素子も第１の構造を有する。

【０１４３】実施の形態６の表示装置は、実施の形態３の表示装置と同じ構造を有しているので、詳細な説明は省略する。以下、実施の形態６の電子放出装置の製造方法、電界放出素子の製造方法（第２Ｄの製造方法）及び表示装置の製造方法を、支持体等の模式的な一部端面図である図１３～図１５を参照して説明する。

【０１４４】［工程－６００］先ず、実施の形態１の［工程－１００］と同様にして、支持体上１０にカソード電極１１を形成する。

【０１４５】［工程－６１０］次いで、実施の形態３の［工程－３１０］と同様にして、全面に絶縁層１２を形成した後、第１の開口部１４Ａを有するゲート電極１３を形成し、更に、絶縁層１２に第２の開口部１４Ｂを形成して、第２の開口部１４Ｂの底部にカソード電極１１を露出させる（図１３の（Ａ）参照）。

【０１４６】［工程－６２０］その後、第２の開口部１４Ｂの底部に露出したカソード電極１１上に、実施の形態１の［工程－１１０］と同様にして薄膜２０を形成する。そのために、先ず、第２の開口部１４Ｂの底部の中央部にカソード電極１１の表面が露出したマスク材料から成るマスク層１６を形成する（図１３の（Ｂ）参照）。具体的には、開口部１４Ａ，１４Ｂ内を含む全面にスピンコート法にてマスク層を成膜した後、リソグラフィ技術に基づき、第２の開口部１４Ｂの底部の中央部に位置するマスク層に孔部を形成することによって、マスク層１６を得ることができる。実施の形態６において、マスク層１６は、第２の開口部１４Ｂの底部に位置するカソード電極１１の一部分、第２の開口部１４Ｂの側壁、第１の開口部１４Ａの側壁、ゲート電極１３及び絶縁層１２を被覆している。これによって、以降の工程で、第２の開口部１４Ｂの底部の中央部に位置するカソード電極１１の部分の表面に薄膜２０を形成するが、カソード電極１１とゲート電極１３とが薄膜２０の形成によって短絡することを確実に防止し得る。そして、実施の形態１の［工程－１１０］と同様にして薄膜２０を形成した後、マスク層１６を除去する（図１４の（Ａ）参照）。

【０１４８】［工程－６４０］次いで、実施の形態１の［工程－１４０］と同様にして、ＣＶＤ法に基づき、選択的に電子放出部形成領域２２上に結晶性を有するグラファイトから成る電子放出部１５を形成する（図１５参照）。

【０１４９】［工程－６５０］その後、実施の形態３の［工程－３２０］と同様の工程を実行し、次いで、実施の形態１の［工程－１５０］と同様にして、表示装置の組み立てを行う。

【０１５０】（実施の形態７）実施の形態７も、実施の形態３の変形である。実施の形態７における電界放出素子は第２の構造を有する。即ち、実施の形態７の電界放出素子は、支持体１０上に配設された絶縁材料から成る帯状のゲート電極支持部１１２、支持体１０上に形成されたカソード電極１１、複数の開口部１１４が形成された帯状材料１１３Ａから成るゲート電極１１３、カソード電極１１上に形成された島状の電子放出部形成領域２２、及び、電子放出部形成領域２２上に形成された電子放出部１５から成る。電子放出部１５は、電子放出部形成領域２２上に形成された結晶性を有するグラファイト（より具体的には、sp^2結合を有するグラファイトから構成されたカーボンナノチューブ）から構成されている。そして、ゲート電極支持部１１２の頂面に接するように、且つ、電子放出部１５の上方に開口部１１４が位置するように帯状材料１１３Ａが張架されている。電子放出装置は、導電体層（実施の形態７においても、具体的には、カソード電極１１）上に形成された形成された島状の電子放出部形成領域２２、及び、電子放出部形成領域２２上に形成された電子放出部から成る。

【０１５１】帯状材料１１３Ａは、ゲート電極支持部１１２の頂面に、熱硬化性接着剤（例えばエポキシ系接着剤）にて固定されている。実施の形態７の電界放出素子の模式的な一部断面図を図１６の（Ａ）に示し、カソード電極１１、帯状材料１１３Ａ及びゲート電極１１３、並びに、ゲート電極支持部１１２の模式的な配置図を図１６の（Ｂ）に示す。

【０１５２】以下、実施の形態７の電界放出素子の製造方法（第２Ｅの製造方法）の一例を説明する。

【０１５３】［工程－７００］先ず、支持体１０上に帯

［工程－１３０］と同様にして、微粒子２１をエッチング用マスクとして薄膜２０に対して異方性エッチングを行い、微粒子２１の下に位置する薄膜２０を選択的に残し、次いで、微粒子２１を除去し、以て、残された薄膜２０から成る島状の電子放出部形成領域２２を形成し、更に、実施の形態１の［工程－１４０］と同様にして、ＣＶＤ法に基づき、選択的に電子放出部形成領域２２上に結晶性を有するグラファイトから成る電子放出部１５を形成する。

【０１５５】［工程－７２０］その後、複数の開口部１１４が形成されたストライプ状の帯状材料１１３Ａを、複数の開口部１１４が電子放出部１５の上方に位置するように、ゲート電極支持部１１２によって支持された状態に配設し、以て、ストライプ状の帯状材料１１３Ａから構成され、複数の開口部１１４を有するゲート電極１１３を電子放出部１５の上方に位置させる。ストライプ状の帯状材料１１３Ａを、ゲート電極支持部１１２の頂面に、熱硬化性接着剤（例えばエポキシ系接着剤）にて固定することができる。尚、ストライプ状のカソード電極１１の射影像と、ストライプ状の帯状材料１１３Ａの射影像は、直交する。

【０１５６】尚、図１７に、支持体１０の端部近傍の模式的な一部断面図を示すように、ストライプ状の帯状材料１１３Ａの両端部が、支持体１０の周辺部に固定されている構造とすることもできる。より具体的には、例えば、支持体１０の周辺部に突起部１１７を予め形成しておき、この突起部１１７の頂面に帯状材料１１３Ａを構成する材料と同じ材料の薄層１１８を形成しておく。そして、ストライプ状の帯状材料１１３Ａを張架した状態で、かかる薄層１１８に、例えばレーザを用いて溶接する。尚、突起部１１７は、例えば、ゲート電極支持部の形成と同時に形成することができる。

【０１５７】実施の形態７の電界放出素子における開口部１１４の平面形状は円形に限定されない。帯状材料１＊１３Ａに設けられた開口部１１４の形状の変形例を図１８の（Ａ）、（Ｂ）、（Ｃ）及び（Ｄ）に例示する。

【０１５８】また、実施の形態７において、［工程－７１０］を実行した後、［工程－７００］を実行してもよい。

【０１５９】以上、本発明を、発明の実施の形態に基づき説明したが、本発明はこれらに限定されるものではない。発明の実施の形態においては、電子放出部をカーボンナノチューブから構成したが、電子放出部を形成するためのＣＶＤ条件によっては、電子放出部をカーボンナノファイバーから構成でき、あるいは又、円錐状の形状を有する電子放出部を形成することも可能である。

【０１６０】電界放出素子においては、専ら１つの開口部に１つの電子放出部が対応する形態を説明したが、電界放出素子の構造に依っては、１つの開口部に複数の電子放出部が対応した形態、あるいは、複数の開口部に１つの電子放出部が対応する形態とすることもできる。あるいは又、ゲート電極に複数の第１の開口部を設け、絶縁層にかかる複数の第１の開口部に連通した１つの第２の開口部を設け、１又は複数の電子放出部を設ける形態とすることもできる。

【０１６１】発明の実施の形態においては、薄膜をスパッタ法にて形成したが、その他、ＣＶＤ法や電解メッキ法にて形成することもできる。例えば、ニッケル（Ｎｉ）から成る薄膜を電解メッキ法に基づき形成するための条件を以下の表４に例示する。尚、陽極としてニッケル板を用いる。また、鉄（Ｆｅ）から成る薄膜を形成するためには、以下の表５に例示する条件の電解メッキを行えばよい。尚、陽極として鉄板を用いる。更には、コバルト（Ｃｏ）から成る薄膜を形成するためには、以下の表６に例示する条件の電気メッキを行えばよい。尚、陽極としてコバルト板を用いる。

【０１６２】
［表４］

メッキ浴組成：	塩化アンモニウム	１重量％
	ホウ酸	２重量％
	硫酸ニッケル	４重量％
	ドデシル硫酸ナトリウム	０．１重量％
メッキ浴温度：	５０゜Ｃ	

：ゲート電極／カソード電極間　０．５ｍＡ／ｄｍ²

【０１６４】

【表６】

メッキ浴組成：	塩化アンモニウム	１重量％
	ホウ酸	２重量％
	硫酸コバルト	４重量％
	ドデシル硫酸ナトリウム	０．１重量％
メッキ浴温度：	５０゜Ｃ	
印加電流	：陽極／ゲート電極間	２５ｍＡ／ｄｍ²
	：ゲート電極／カソード電極間	０．５ｍＡ／ｄｍ²

【０１６５】本発明の冷陰極電界電子放出素子において、ゲート電極１３及び絶縁層１２の上に更に第２の絶縁層６２を設け、第２の絶縁層６２上に収束電極６３を設けてもよい。このような構造を有する電界放出素子の模式的な一部端面図を図１９に示す。第２の絶縁層６２には、第１の開口部１４Ａに連通した第３の開口部６４が設けられている。収束電極６３の形成は、例えば、実施の形態３にあっては、［工程－３１０］において、絶縁層１２上にストライプ状のゲート電極１３を形成した後、第２の絶縁層６２を形成し、次いで、第２の絶縁層６２上にパターニングされた収束電極６３を形成した後、収束電極６３、第２の絶縁層６２に第３の開口部６４を設け、更に、ゲート電極１３に第１の開口部１４Ａを設ければよい。尚、収束電極のパターニングに依存して、１又は複数の電子放出部、あるいは、１又は複数の画素に対応する収束電極ユニットが集合した形式の収束電極とすることもでき、あるいは又、有効領域を１枚のシート状の導電材料で被覆した形式の収束電極とすることもできる。

【０１６６】尚、収束電極は、このような方法にて形成するだけでなく、例えば、厚さ数十μｍの４２％Ｎｉ－Ｆｅアロイから成る金属板の両面に、例えばＳｉＯ$_2$から成る絶縁膜を形成した後、各画素に対応した領域にパンチングやエッチングすることによって開口部を形成することで収束電極を作製することもできる。そして、カソードパネル、金属板、アノードパネルを積み重ね、両パネルの外周部に枠体を配置し、加熱処理を施すことによって、金属板の一方の面に形成された絶縁膜と絶縁層１２とを接着させ、金属板の他方の面に形成された絶縁膜とアノードパネルとを接着し、これらの部材を一体化け、かかるスイッチング素子の作動によって、各画素を構成するカソード電極への印加状態を制御し、画素の発光状態を制御する。

【０１６８】あるいは又、カソード電極を、有効領域を１枚のシート状の導電材料で被覆した形式のカソード電極とすることもできる。この場合には、１枚のシート状の導電材料の所定の部分に、電界放出素子から成り、各画素を構成する電子放出領域を形成しておく。そして、カソード電極に電圧（例えば０ボルト）を印加する。更には、各画素を構成する矩形形状のゲート電極とゲート電極制御回路との間に、例えば、ＴＦＴから成るスイッチング素子を設け、かかるスイッチング素子の作動によって、各画素を構成する電子放出部への電界の加わる状態を制御し、画素の発光状態を制御する。

【０１６９】

【発明の効果】本発明の電子放出装置及びその製造方法、冷陰極電界電子放出素子及びその製造方法、並びに、冷陰極電界電子放出表示装置及びその製造方法においては、微粒子の径を適切に選択することによって、微細な電子放出部形成領域を得ることができる結果、電子を放出する部分である先端部が先鋭化された電子放出部を得ることができる。それ故、電子放出部からの電子放出の効率が向上し、また、閾値電位ΔV_{th}の低減を図ることができ、ちらつきを抑えた画像表示の安定した、且つ、低消費電力の冷陰極電界電子放出表示装置を提供することができる。しかも、電子放出部が結晶性を有するグラファイトから構成されているので、低閾値電位ΔV_{th}を達成することができる。

【０１７０】また、微粒子の径と概ね等しい径を有する電子放出部を形成することができるので、微粒子を変更

出素子を具備した冷陰極電界電子放出表示装置を安価に形成することができる。

【０１７１】また、本発明の薄膜のエッチング方法によれば、微粒子の径を適切に選択することによって、現在のフォトリソグラフィ技術の限界以下の微細な領域を薄膜に形成することができる。更には、溶媒中に微粒子を分散させておけば、溶媒中の微粒子の量を変更することによって、エッチングされて残された薄膜の密度を所望の密度に容易に制御することができる。

【図面の簡単な説明】

【図１】発明の実施の形態１の冷陰極電界電子放出表示装置の模式的な一部断面図である。

【図２】発明の実施の形態１における冷陰極電界電子放出素子の製造方法を説明するための支持体等の模式的な一部断面図である。

【図３】発明の実施の形態１の冷陰極電界電子放出表示装置におけるアノードパネルの製造方法を説明するための基板等の模式的な一部断面図である。

【図４】発明の実施の形態１の冷陰極電界電子放出表示装置の変形例における１つの電子放出部の模式的な斜視図である。

【図５】発明の実施の形態３の冷陰極電界電子放出表示装置の模式的な一部端面図である。

【図６】発明の実施の形態３の冷陰極電界電子放出表示装置におけるカソードパネルとアノードパネルを分解したときの模式的な部分的斜視図である。

【図７】発明の実施の形態３における冷陰極電界電子放出素子の製造方法を説明するための支持体等の模式的な一部端面図である。

【図８】図７に引き続き、発明の実施の形態３における冷陰極電界電子放出素子の製造方法を説明するための支持体等の模式的な一部端面図である。

【図９】発明の実施の形態４における冷陰極電界電子放出素子の製造方法を説明するための支持体等の模式的な一部端面図である。

【図１０】図９に引き続き、発明の実施の形態４における冷陰極電界電子放出素子の製造方法を説明するための支持体等の模式的な一部端面図である。

【図１１】発明の実施の形態５における冷陰極電界電子放出素子の製造方法を説明するための支持体等の模式的

ける冷陰極電界電子放出素子の製造方法を説明するための支持体等の模式的な一部端面図である。

【図１３】発明の実施の形態６における冷陰極電界電子放出素子の製造方法を説明するための支持体等の模式的な一部端面図である。

【図１４】図１３に引き続き、発明の実施の形態６における冷陰極電界電子放出素子の製造方法を説明するための支持体等の模式的な一部端面図である。

【図１５】図１４に引き続き、発明の実施の形態６における冷陰極電界電子放出素子の製造方法を説明するための支持体等の模式的な一部端面図である。

【図１６】発明の実施の形態７における冷陰極電界電子放出素子の模式的な一部断面図、及び、ゲート電極等の模式的な配置図である。

【図１７】発明の実施の形態７の変形例における冷陰極電界電子放出素子の模式的な一部断面図である。

【図１８】発明の実施の形態７におけるゲート電極の有する複数の開口部を示す模式的な平面図である。

【図１９】発明の実施の形態３の冷陰極電界電子放出素子の変形であって、収束電極を備えた冷陰極電界電子放出素子の模式的な一部端面図である。

【図２０】スピント型冷陰極電界電子放出素子を備えた従来の冷陰極電界電子放出表示装置の構成例を示す模式図である。

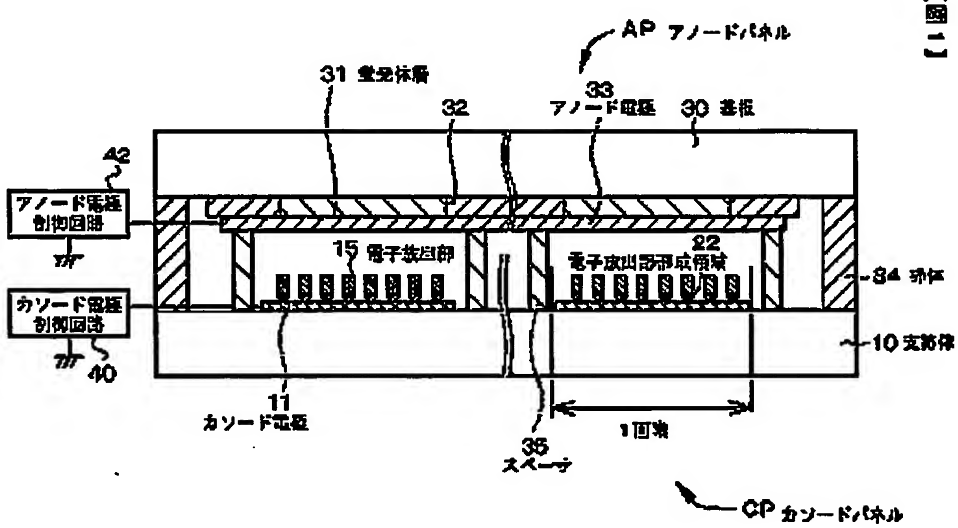
【図２１】従来のスピント型冷陰極電界電子放出素子の製造方法を説明するための支持体等の模式的な一部端面図である。

【図２２】図２１に引き続き、従来のスピント型冷陰極電界電子放出素子の製造方法を説明するための支持体等の模式的な一部端面図である。

【符号の説明】

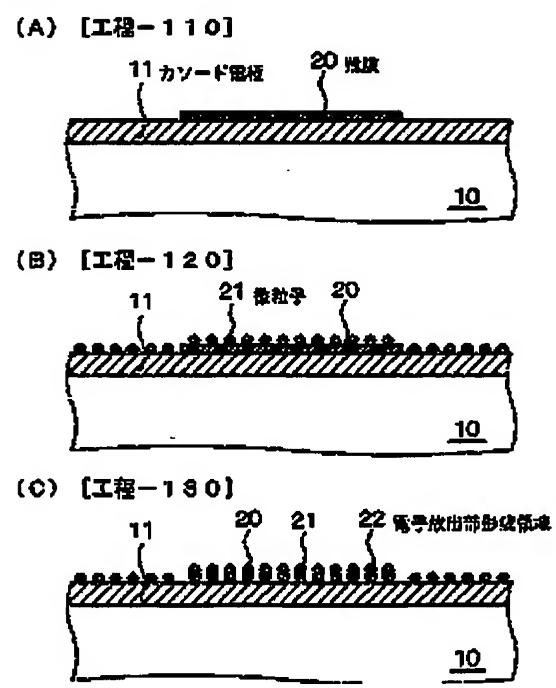
ＣＰ・・・カソードパネル、ＡＰ・・・アノードパネル、１０・・・支持体、１１・・・カソード電極、１２・・・絶縁層、１１２・・・ゲート電極支持部、１３，１１３・・・ゲート電極、１４，１４Ａ，１４Ｂ，１１４・・・開口部、１５・・・電子放出部、１６・・・マスク層、２０・・・薄膜、２１・・・微粒子、２２・・・電子放出部形成領域、３０・・・基板、３１，３１Ｒ，３１Ｇ，３１Ｂ・・・蛍光体層、３２・・・ブラックマトリックス、３３・・・アノード電極、３４・・・

【図１】


AP アノードパネル
31 蛍光体層
32
33 アノード電極
30 基板
42
アノード電極制御回路
15 電子放出部
22 電子放出部形成領域
34 枠体
カソード電極制御回路
10 支持体
40
11 カソード電極
1画素
スペーサ
CP カソードパネル

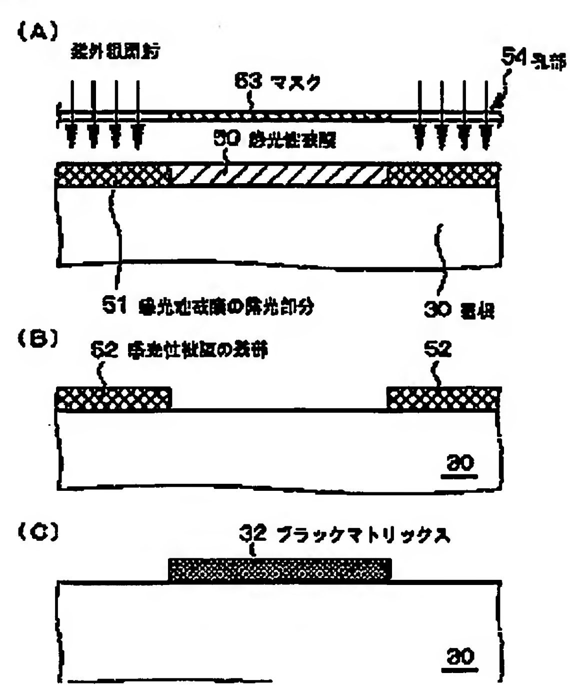
【図２】

【図２】

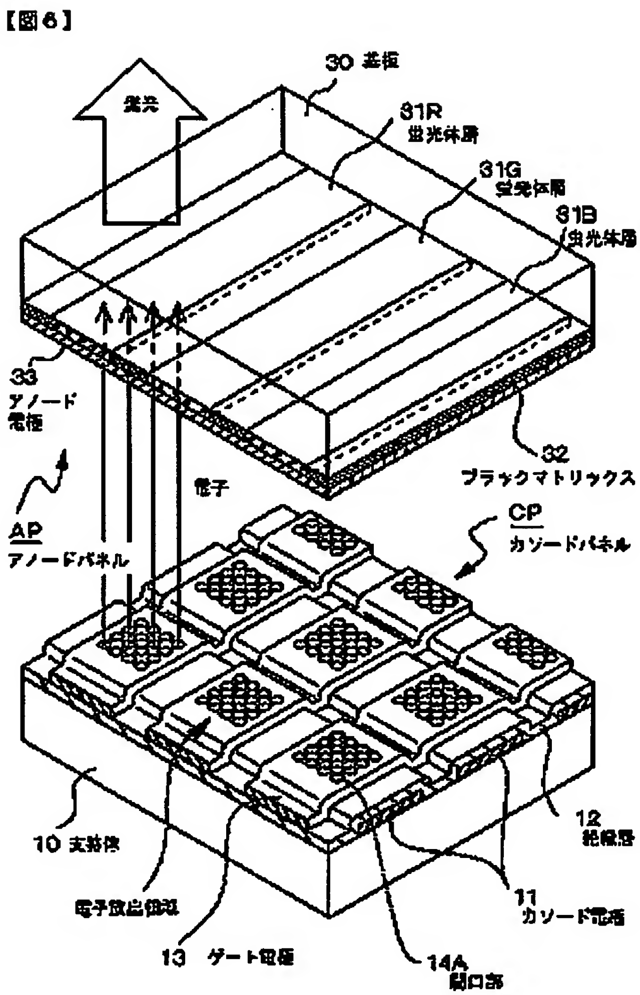

(A) [工程－１１０]
11 カソード電極
20
10
(B) [工程－１２０]
11
21 微粒子
20
10
(C) [工程－１３０]
11
20
21
22 電子放出部形成領域
10

【図３】

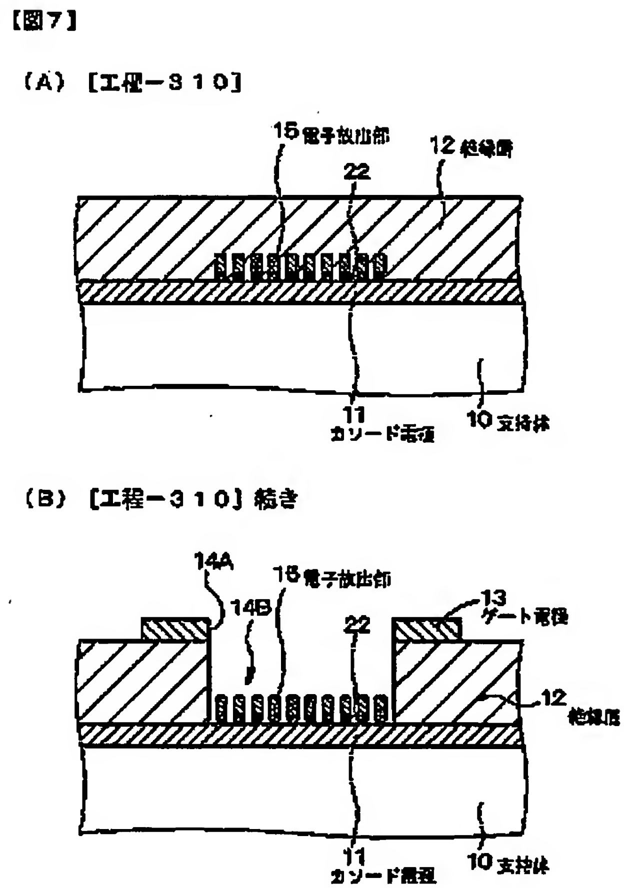
【図３】


(A)
紫外線照射
54 孔部
63 マスク
50 感光性被膜
51 感光性被膜の露光部分
30 基板
(B)
52 感光性被膜の残部
52
30
(C)
32 ブラックマトリックス
30

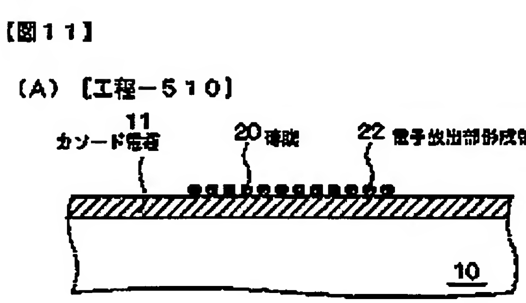
【図６】


【図6】
30 基板
発光
31R
蛍光体層
31G
蛍光体層
31B
蛍光体層
33
アノード
電極
32
ブラックマトリックス
電子
AP
アノードパネル
CP
カソードパネル
10 支持体
12
絶縁層
11
カソード電極
電子放出領域
13 ゲート電極
14A
開口部

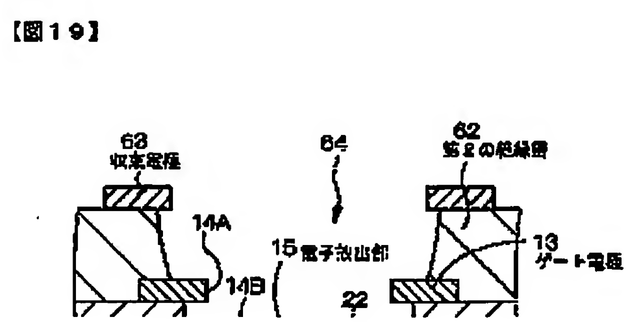
【図７】


【図7】
(A) [工程－３１０]
15 電子放出部
12 絶縁層
22
11
カソード電極
10 支持体
(B) [工程－３１０] 続き
14A
15 電子放出部
14B
22
13
ゲート電極
12
絶縁層
11
カソード電極
10 支持体

【図１１】


【図11】
(A) [工程－５１０]
11
カソード電極
20 薄膜
22 電子放出部形成領域
10

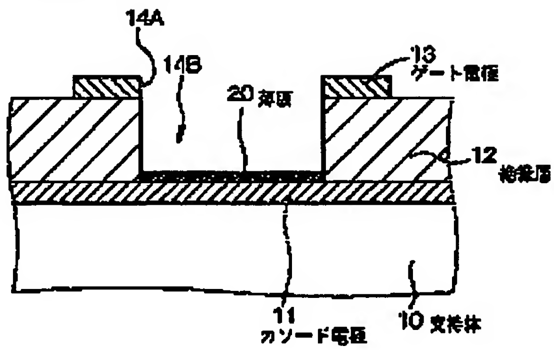
【図１９】


【図19】
63
収束電極
64
62
第２の絶縁層
14A
15 電子放出部
13
ゲート電極
14B
22

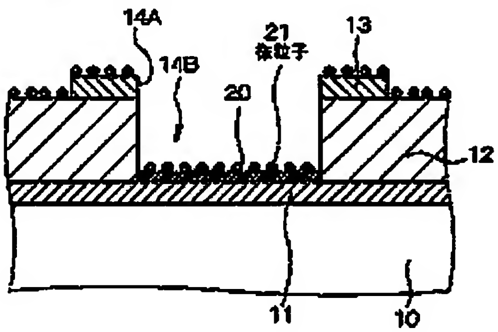
【図９】

【図9】

(A) [工程－４１０]



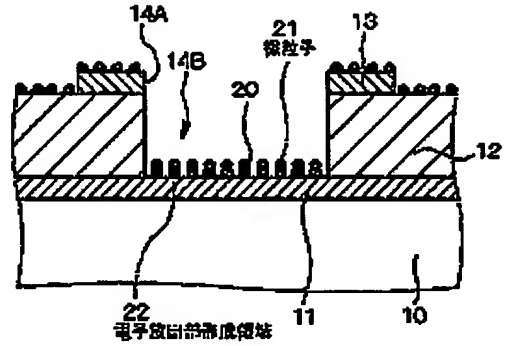
(B) [工程－４２０]



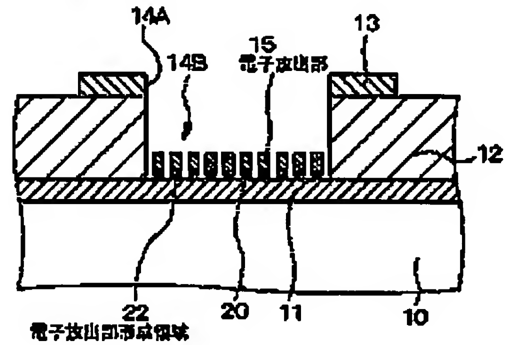
【図１０】

【図10】

(A) [工程－４３０]



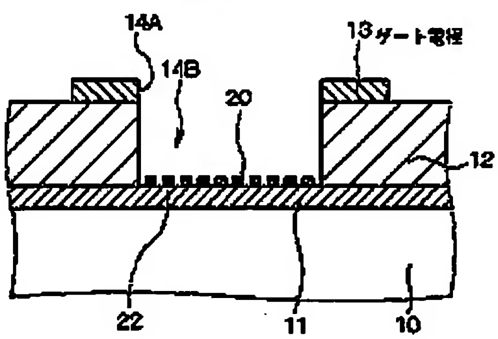
(B) [工程－４４０]



【図１２】

【図12】

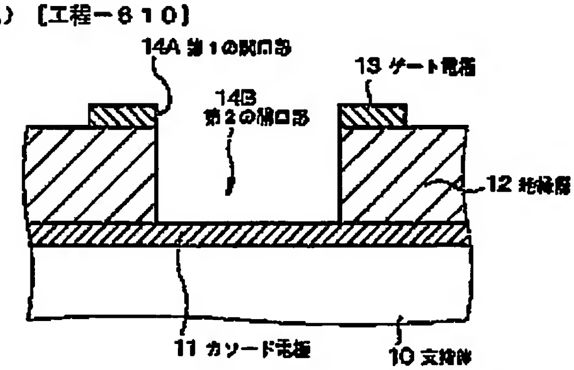
(A) [工程－５２０] 続き



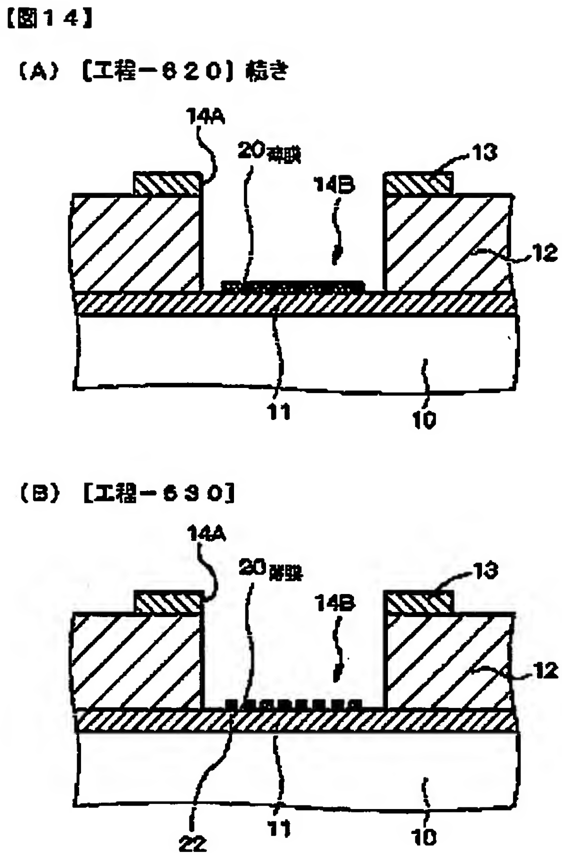
【図１３】

【図13】

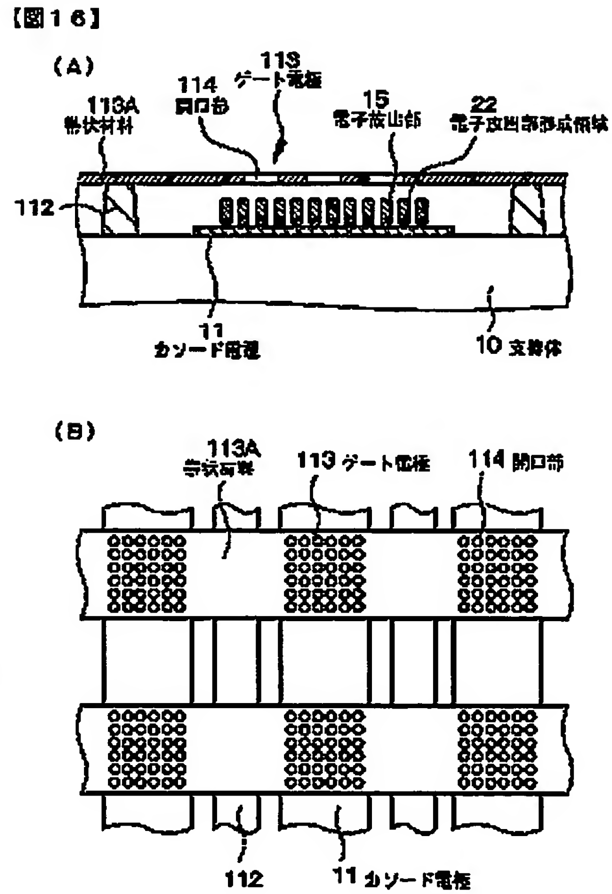
(A) [工程－６１０]



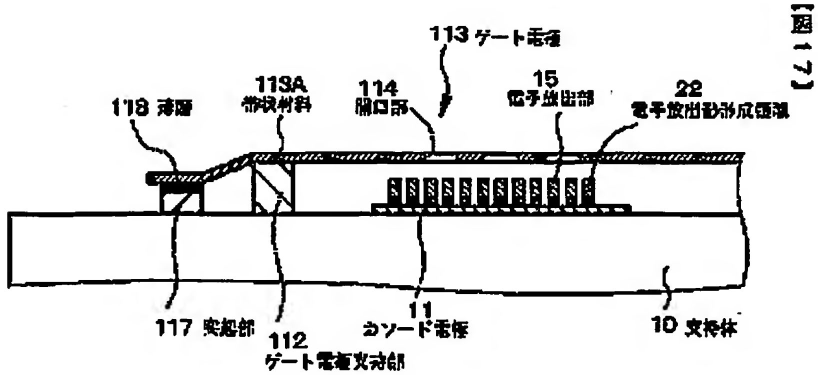
【図14】



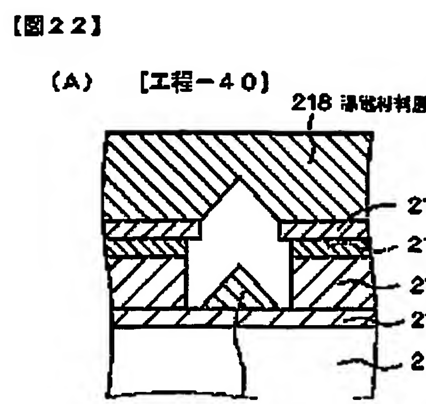
【図16】



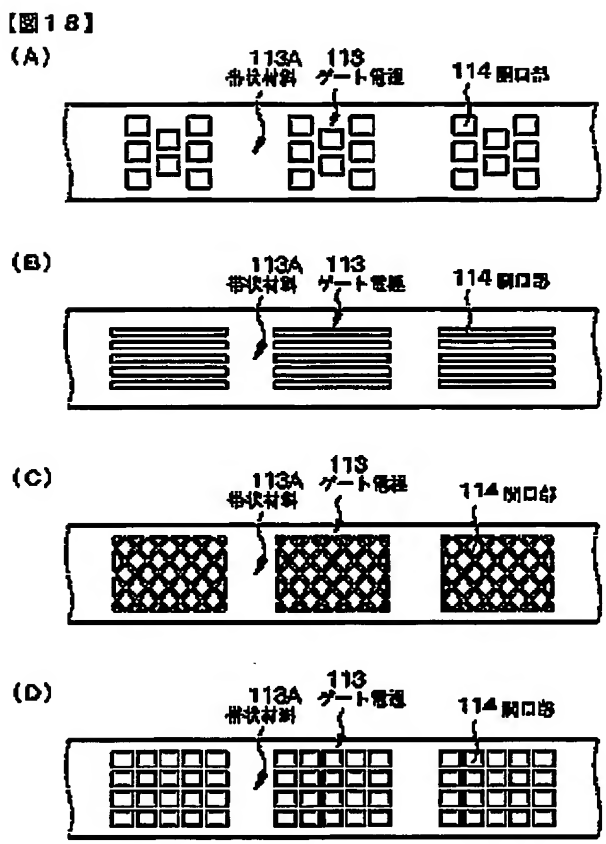
【図17】



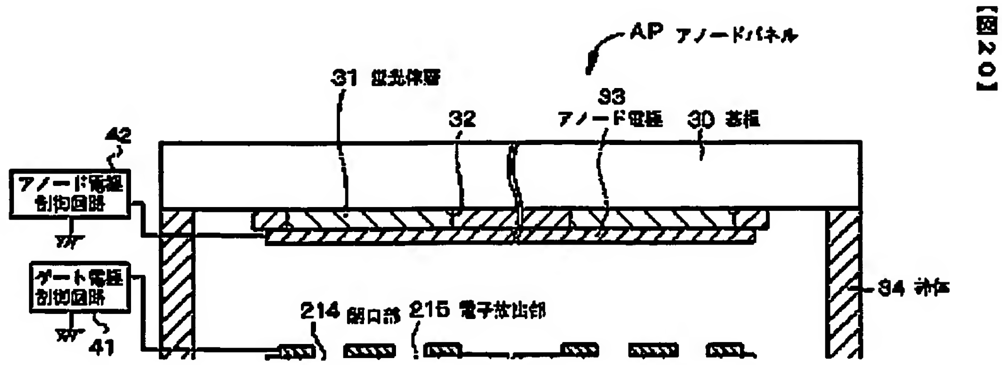
【図22】



【図１８】


【図１８】
(A)
113A 帯状材料
113 ゲート電極
114 開口部
(B)
113A 帯状材料
113 ゲート電極
114 開口部
(C)
113A 帯状材料
113 ゲート電極
114 開口部
(D)
113A 帯状材料
113 ゲート電極
114 開口部

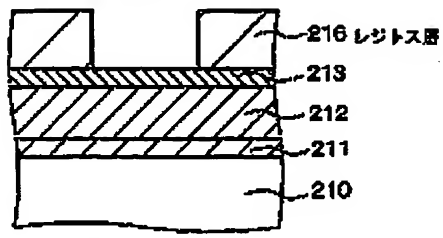
【図２０】


【図２０】
AP アノードパネル
31 蛍光体層
32
33 アノード電極
30 基板
42
アノード電極制御回路
ゲート電極制御回路
41
214 開口部
215 電子放出部
34 枠体

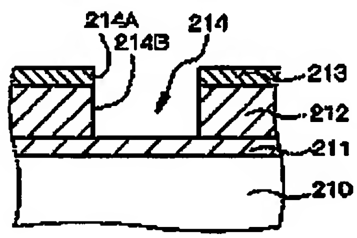
【図21】

【図21】

(A) 【工程−20】



(B) 【工程−20】続き



(C) 【工程−30】